COMPARING THE RISK OF TUBERCULOSIS (TB) INFECTION IN THE HOUSEHOLDS WITH AND WITHOUT TB PATIENTS IN TSUMKWE CONSTITUENCY, OTJOZONDJUPA REGION, NAMIBIA

SUBMITTED IN PARTIAL FULLFILMENT OF THE REQUIREMENT FOR THE DEGREE OF MASTER OF SCIENCE IN APPLIED FIELD EPIDEMIOLOGY

OF

THE UNIVERSITY OF NAMIBIA

BY

ALBERTINA THOMAS

SEPTEMBER 2014

STUDENT NO: 8204837

MAIN SUPERVISOR: DR K. HOFNIE-//HOËBES

CO-SUPERVISOR: DR PENEHAFO ANGULA

ABSTRACT

Namibia is among the countries with the highest per capita burden of tuberculosis. The traditional San community that are living in northern Namibia are heavily burdened by the TB disease partly due to high household density. This study compares the risk of transmission of TB among close contacts with the community contacts.

A retrospective cohort study was conducted and data, of index cases registered during 2014 and their close and community contacts, was collected using health facility registers. Structured questionnaires were used to interview index cases and their contacts, and for the examination of active disease. Tuberculin skin test (TST) was performed on contacts without active disease. Risk of disease and infection in the close contacts were compared with the corresponding risks in community contact, by calculating risk ratio at 95% confidence interval.

Twenty-three registered patients were visited and 66 close contacts and 102 community contacts were interviewed and screened. Eight (12%) out of the 66 close contacts and 8(8%) out of the 102 community contacts were diagnosed with active TB disease. The risk for developing the disease was higher in the close contacts than the community contacts (RR: 1.5; 95% CI: 0.6 – 2.39), but not statistically

significant. When adjusted for age, the children who are close contacts had a higher risk to develop TB disease.

Twelve (37.5%) out of the 32 close contact and 17(31%) out of the 54 community contacts tested, reacted positive to TST. The risk of infection in the close contacts and community contacts were the same (RR: 1.1; 95% CI: 0.65 – 2.16).Age adjusted risk ratio suggested a reduced risk of infection for children (RR: 0.66; 95% CI: 0.2 – 1.7).

Close and community contacts of TB patients in Tsumkwe constituency have an equal risk of acquiring infection and developing TB disease when infected. Young age was slightly protective against infection.

RECOMMENDATIONS: It is recommended that case finding be intensified and genotypic testing be considered to link index and secondary cases.

TABLE OF CONTENT

LIST OF ANNEXURES

LIST OF FIGURES

LIST OF TABLES

ACKNOWLEDGEMENTS

I sincerely thank my supervisors, Dr. K. Hofnie-//Hoëbes and Dr. Penehafo Angula for their support and mentorship in the completion of this thesis. My special gratitude is extended to late Registered Nurse R. Makayi, nurse in-charge of TB out patients department (OPD) at Tsumkwe clinic and TB field promoters G/aq'o #Oma and Gerhard Jebbes for their assistance during the study period. I especially want to thank the Otjozondjupa regional management under the leadership of Director, Ms Maria Kavezembi and the Grootfontein district management for their readiness to accommodate me in the region and district. I further wish to express my heartfelt thanks to the U.S. Centres for Disease Control and Prevention (CDC) Namibia for their financial and technical support. Special thanks go to the Epidemiology Division in the Ministry of Health and Social Services (MOHSS) for their logistical and administrative support. Lastly, my particular gratitude is extended to the study participants, especially the Ju /'hoansi communities from Tsumkwe, Duinpos, Kapteinpos, Ben se Kamp, Mountain pos, N#amapan, //Auru and /A//oba,who participated in this study with so much eagerness. It was an incredible experience to work with them.

DEDICATION

This thesis is dedicated to my son Vaughan Reinhold Thomas in acknowledgement for his encouragement during the time of my studies.

LIST OF ABBRECIATIONS AND ACRYNOMS

BMI = Body Mass Index

CDC = Centre of Disease Control and Prevention

CNR = Case Notification Rate

DR-TB = Drug Resistant Tuberculosis

DST = Drug Susceptible Testing

ETR= Electronic TB register

GDP= Gross Domestic Product

GIS = Geographic Information System

HDI= Human Development Index

IPT = Isoniazid Preventive Therapy

LTBI = Latent TB infection

HIV = Human Immunodeficiency Virus

MOHSS = Ministry of Health and Social Services

MDR-TB = Multi drug resistant TB

MTB = Mycobacterium Tuberculosis

NTLP = National TB and Leprosy Programme

PPD = Purified Protein Derivate

RR = Relative Risk/Risk ratio

TB= Tuberculosis

TBL MTPII= Second Medium Term Strategic Plan for Tuberculosis and Leprosy 2010-2015

TST = Tuberculin Skin Test

UNAM = University of Namibia

U.S.A. = United States of America

WHO= World Health Organization

XDR-TB = Extensively Drug Resistant TB

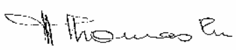
DECLARATIONS

I, Albertina Martha Thomas, declare hereby that this study is a true reflection of my own research, and that this work, or part thereof has not been submitted for a degree in any other institution of higher education.

No part of this thesis/dissertation may be reproduced, stored in any retrieval system, or transmitted in any form, or by means (e.g. electronic, mechanical, photocopying, recording or otherwise) without the prior permission of the author, or The University of Namibia in that behalf.

I, Albertina Martha Thomas, grant The University of Namibia the right to reproduce this thesis in whole or in part, in any manner or format, which The University of Namibia may deem fit, for any person or institution requiring it for study and research; providing that The University of Namibia shall waive this right if the whole thesis has been or is being published in a manner satisfactory to the University.

Albertina Martha Thomas 3 November 2015

……………………………  Date……………………..

[Student's name]

CHAPTER 1: INTRODUCTION AND BACKGROUND TO THE STUDY

1.1 Orientation of the study

The focus of this study was to compare the risk of tuberculosis (TB) transmission in households with TB patients with the risk among those living in households without TB patients in the same homestead in Tsumkwe constituency, Namibia. Tsumkwe constituency is under the health management of Otjozondjupa region and Grootfontein district for health service management. The total population for this constituency is approximately 9 900 people and the constituency occupies an area of approximately 20 000 km^2 (Namibian Population and Housing census 2011).

Clinical records and health facility registers have indicated high numbers of both drug-susceptible and drug-resistant TB among the indigenous San people in Tsumkwe area. Their vulnerability as a marginalised community with limited access to health services has had an aggravating effect on their susceptibility to disease and TB transmission (Suzman, 2001). The incidence of TB is closely linked to poverty and poor social conditions, and many studies have revealed that poor communities have high incidence and case fatality rates due to TB (Chauhan, Dara, Figueroa-Munoz, Hanson, Martinez, 2005).

1.2 Background of the study:

Tuberculosis (TB) is a preventable and curable disease that continues to pose serious challenges for public health in the world, especially in low-income countries. It is reported as one communicable disease that contributes significantly to the number of deaths globally. Globally, an estimated nine million people developed TB and of those 1.5 million died of the disease in 2013.Closeto one-fourth (24%) of those who died of TB were HIV-positive (WHO Global report 2014).

Tuberculosis is a preventable disease, however, the mortality rate among TB patients is unacceptably high. Globally, it is estimated that 37 million deaths from TB were prevented between 2000 and 2013by implementing global strategies such as Stop TB strategy. Efforts to combat TB deaths therefore need to be accelerated in order to meet the 2015 global targets (WHO Global report 2013).

While tuberculosis occurs in every part of the world, Africa bears the greatest proportion of new cases per population with 280 cases per 100,000 population in 2013. Sub-Saharan Africa reports that 28% of new adult TB cases are infected with HIV/AIDS, giving the region the highest co-infection rate in the world (WHO fact sheet 2015). The spread of HIV is cited to be responsible for the increase in TB incidence in sub-Saharan Africa. In the African context, TB leading cause of death among HIV-positive patients (WHO Global report 2013).

Historically, TB was seen as the disease of the poor and currently evidence exists that poverty is a social determinant of tuberculosis in the world. A study done by Jansen and Rieder (2008) recorded a linear association between per capita Gross Domestic Product (GDP) and TB incidence. This correlation of GDP and TB was shown for China, India and UK, and each doubling of GDP was associated with 38.5% decrease of TB incidence. This is a clear indication of the significant role social determinants are playing in health and disease patterns (Jansen & Rieder, 2008).

Dye and colleagues (2009) further documented that countries with high human development index (HDI), low child mortality and access to sanitation had shown a decrease in TB incidence over time. The documented findings suggest that if countries continue to maintain high human development indices, disease burden can be significantly reduced. The findings are also supported by reports on human development indices (Dye, Lonnroth, Jaramillo, Williams & Raviglione, 2009).

The association between TB and poverty has been demonstrated by various studies. Oxlade and Murray (2012) did an assessment on TB social determinants and household socio-economic status. It was found that low BMI has the strong facilitating effect on TB incidence (Oxlade & Murray 2012). While poverty is recognised as the known risk factor for TB, the specific risk factor that mediate incidence of TB was pointed out as low BMI, which is an indicator of poor nutrition.

These researchers were trying to do an in-depth investigation on the specific proximal risk factors for disease, but ultimately the final supposition is the impact of poverty on the health of people.

In the light of the aforesaid information, poverty, unequal distribution of resources, and poor access to health services escalate the global burden of disease. As a consequence poor people and those from disadvantaged societies are the ones who suffer more illness and die in a shorter time that those who are from the privileged groups. These poor and socially marginalised people are also the ones that are vulnerable to many health threats and when they fall ill are also less likely to receive the appropriate care and support (WHO, 2005).

Although Namibia is among the countries that are worst-affected by TB, significant improvements have been made in the country in terms of TB diagnosis, treatment and care. The introduction of the Second Medium Term Strategic Plan on Tuberculosis and Leprosy (MTPII) in 2005 has facilitated these strides. Interventions to combat TB/HIV co-infection were also scaled up during the same period. On the contrary, regional trends continued to show variations in case notification and some regions had better treatment outcomes than others. This occurrence can be partially attributed to the vastness of the country and the differences in terms of resource availability.

The Namibian Human Development Report described the Khoisan-speaking people, comprising the San people, as those with the worst human indices and health conditions in the country. It is therefore inevitable that socio-economic status is a primary determinant of health outcomes in this population. The results of an analysis in Southern Africa underscore the certainty of that fact. A retrospective analysis was done in Lesotho to detect the early outcomes of multi-drug resistant TB (MDR-TB). The analysis disclosed that patients that received social and nutritional support had better outcomes than those who did not receive the relevant social support. The social and nutritional support was combined with the relevant treatment options available and yielded the documented health outcomes (Seung, Omatayo, & Keshavjee, 2009).

The nomadic San community, inhabitants of the outskirts of northern Namibia, are written about with reference to their poor social status and been a marginalised community. They used to practice a traditional hunter-gatherer lifestyle. They have a unique social structure and lived as extended families in their homesteads. The San people form non-dominant groups in society and resolve to maintain and reproduce their ancestral environment and systems as distinct people (WHO 2007). The San community has been driven away from their traditional lifestyle because of expanding civilisation.

The background paper on the Namibian Human Development Report describes the human development index (HDI) of different language groups. The Khoisan speaking people which comprises of the San have the lowest life expectancy, literacy level, school enrolment and income compared to other Namibian language groups. The San people are described as the most impoverished, disempowered, and marginalised community in Southern Africa (Levine, 2007).

Intensified efforts have been made to address TB control among this distinct community of Tsumkwe as well as other communities in the surrounding villages of Grootfontein district of the high burdened Otjozondjupa region. Passive case finding has been replaced with intensified TB case finding and contact tracing has been enforced (MoHSS2012). While TB cases declinedfrom2009 to2011 in Otjozondjupa region, treatment success rates also declined from 2009 to 2010. The declining treatment success rates were attributed to high treatment failure rates, especially among the San community (MoHSS2013). The undesirable treatment outcomes were a major concern and community involvement was enhanced to raise the awareness of the community about tuberculosis and the spread of the disease (Uukunde, Mungunda,Ruswa,Mavhunga, Platt & Goenka, 2011).

Despite the fact that control measures were intensified, strong scientific evidence is required to make the prevention and care approach more focussed. As a result, investigation of risk factors and other contributing factors is required to address undesirable disease trends. Moreover, the transmission dynamics of tuberculosis remain ambiguous. TB transmission studies have revealed that while household members are perceived as the most vulnerable ones for the risk of transmission from their immediate contacts, people from the same household might carry different strains of the *Mycobacterium tuberculosis* bacillus. This signals that people were exposed to a different strain of TB than that from the presumed household source cases.

A study conducted in Poland to investigate the transmission of TB in 35 households has supported the above notion. Contacts had strains of the bacilli that were different from the source case. The researchers used molecular epidemiological investigation with genotyping methods to determine the strains of the bacillus with which the contacts were infected. This study suggested that the household is the most important reservoir of TB transmission since 85% of cases were infected by a household source, while the rest were linked to a source outside the household (Augustynowicz-Kopeć, Jagielski, Kozińska, Kremer, van Soolingen, Bielecki, et al 2012). The remaining 15%, that has strains from sources other than the immediate contacts remains a concern for TB control and prevention.

Buu and colleagues (2010) are partly in agreement with the findings as above. Their study assessed the transmission of tuberculosis within and outside of household. They found that 83% of recently infected household members were diagnosed with variant strains when genotyping was done. The transmission of the bacillus frequently occurs outside the household, raising red flags for action. These results argue against contact tracing that is focussing merely on the immediate household contacts, it is deemed to be ineffective (Buu, van Soolingen, Huyen, Mai, Nguyen and Quy et al, 2010).

Furthermore, recent work on molecular epidemiology and transmission dynamics of *Mycobacterium tuberculosis* showed strain diversity in TB infected patients. In contrast to commonly held view that infection is mostly transmitted by a close source in the immediate environment, the findings highlighted the possibility of infection from an unknown source. The findings of the study is in agreement with the aforementioned findings, and point to the high possibility of infection from a source other than the most apparent source, which is usually the household (Tessema, Beer, Merker, Emmrich& Sack 2013).

One more study also underscored the likelihood and prevalence of TB transmission in the community. Andrews and Morrow (2014) used social contact data and environmental data to describe the transmission patterns in a community from a township in South Africa. They used extensions of Wells-Riley transmission model and created an age-structured transmission model in households, transit areas, schools and workplaces. The study yielded that many infections (84%) occurs outside the household and for young adults 50% of infection takes place in schools because of high contact rates and poor ventilation. Transit areas and households were hypothesised as the hot spots for transmission. However the results of this study suggested that a minority of transmission occur in the household and transit areas for the younger age-groups (Andrew, Morrow, Walensky & Wood, 2014). Noteworthy is the fact that the study does not argue against the risk of transmission in the confined environment of the household, but it highlighted the special changing aspects that age can bring about.

Other contributing factors for household transmission are reported by a study done by Inoue and colleagues (2008). Advanced age and cavitary lesions of index cases were associated with multiple secondary cases in the household. Therefore while transmission outside the household is possible, other risk factors are aggravating the transmission risk of TB in the household (Inoue, Koyasi & Hattori, 2008).

The health system in Namibia is geared towards providing equal access and tries to display an equitable approach to testing for TB, diagnosing and dispensing treatment to TB patients in the population of the country. However in actual fact the access to diagnosis, and thus treatment, is not equally available for the already marginalised San people. They are reporting to researchers that they are often blamed for their TB outcomes. They received the blame if their treatment fails or when they develop resistance to TB medicine. They further reported that they are confused when it comes to their TB treatment and health outcomes. On the positive side the co-infection between TB and HIV is low in this population but the San are worse affected by poverty and lack of social power (Gibson, 2010).

According to annual reports of the national TB programme, Tsumkwe clinic is contributing a significantly number to the DR-TB burden; however the incidence of reported DR-TB cases has declined over a 5-year period. The latter conclusion is based on a trend analysis done of cases found in the Tsumkwe facility register. See the trend of DR-TB cases over the period of 2010-2014 registered in Tsumkwe clinic in Figure 1.1:

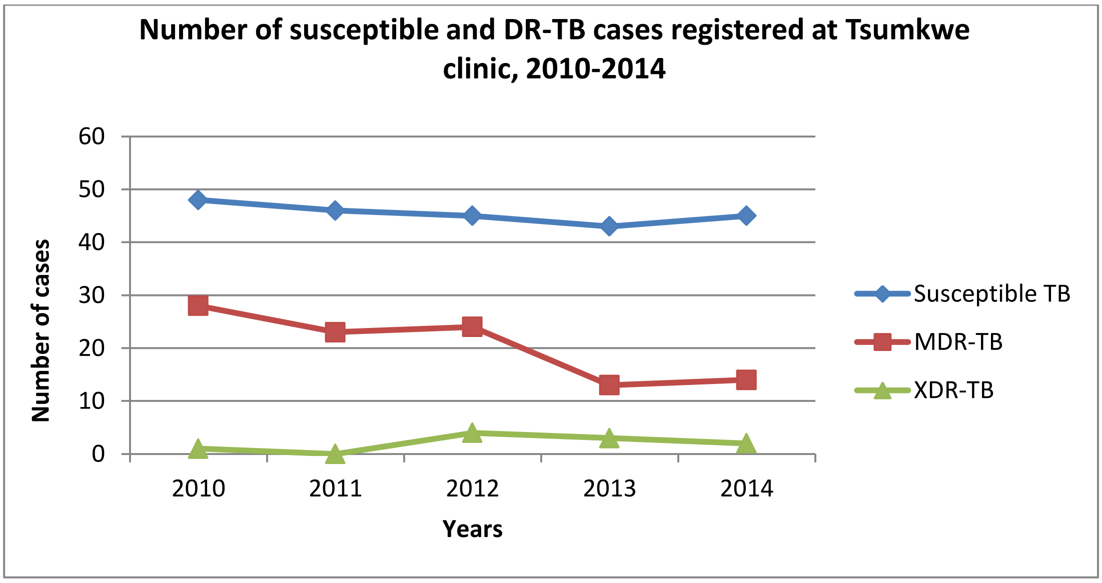


Figure 1.1 Trend of susceptible and DR-TB patients registered at Tsumkwe clinic, 2010-2014

While the per capita burden of TB is high for the San community, the prevalence rate of TB has drop over the 10 years since 2004 in Namibia; a decline in incidence was reported too. Treatment success rate improved from 61% in 2003 to 88% in 2013.However Namibia has the fourth highest per capita burden of TB disease in the world. The distribution of wealth is also much skewed, and wealth is in the hands of a very few people (World Bank 2013). The country is classified as an upper-middle income country, but was ranked as having the highest levels of inequality (Jauch, Edwards & Cupido, 2010).Another factor is some regions are severely affected by TB compared to others (Nam News Network 2014).

Nationally, disease trends are monitored through case notification rates (CNR). A continued downward trend in both CNR and absolute numbers of TB cases has been observed since 2005. Namibia reported 10 610 cases of all forms of TB in 2012, which translates to a CNR of 499 cases per 100,000 population. During the same period in 2011, 11,145 cases were reported (CNR 545/100,000). Region-specific notifications of new cases vary with some regions more heavily affected than others in Namibia. Otjozondjupa had a high CNR of 815 per 100 000 population in 2011 but a decline was reported in 2013. The CNR was 649 per 100 000 population but in terms of the failure rate (13%) the region was among the five highest regions. Grootfontein district had the highest number of new cases in the region, and Tsumkwe constituency, which is part of Grootfontein district, contributed the highest numbers of DR-TB and susceptible TB, according to the district statistics (MOHSS 2013-2014).

Van Wyk and Mandalakas (2012) conducted a study in South Africa on contact investigation and found that four families, consisting of 25 members were sharing the same plot. The index case was living in the main house, half of the families were sharing the same kitchen, and the others were in adjacent structures. Three children from adjacent households were diagnosed with TB and one was referred for Isoniazid Preventive Therapy (IPT) since the child had latent TB (Van Wyk, Mandalakas, Enorson, 2012). The finding of this study shares the same arguments with other studies that infection cannot be attributed to immediate household members alone, especially when this special type of living arrangements exists. It is therefore paramount to understanding the dynamics around transmission of TB whether it is in the house or outside immediate environment, in heterogeneous settings.

More evidence is needed to understand the transmission dynamics of tuberculosis among the heterogeneous communities given the variation of evidence provided by studies. While some studies underscore the household infection risk others underline the risk in the community. Jia, Liu and Feng (2007) reviewed the transmission models used in studies of TB transmission models. The documented review indicated casual factors, among others as the reasons for TB epidemic in some countries. The casual factors such as mass public transport and transit areas can facilitate the transmission of tuberculosis in the community. One of the studies that was used in this review argued that casual contact together with genetic factors were responsible for 30-40% of the total new cases reported in recent years. This review also pointed out that research done on transmission dynamics in heterogeneous populations would be more informative then studies done in homogenous populations (Jia, Li & Feng, 2007).

The traditional San people are living in Tsumkwe constituency with extended families in homestead consisting of 3-5 huts in a radius of 100-200 meter and exposure to infection outside of the immediate household is therefore likelihood. (Gibson, 2010). Verver, Warren and Munch (2004) did a study to determine the proportion of transmission of infection that take place in the household compared to outside the household setting, in a high-incidence area. The study revealed that 46% of contacts had a strain other than the index case but similar to another member of the household. Only 19% of contacts had a strain similar to the index case. This evidence concurs with other studies findings that the while transmission inside the household continue, proportion of transmission outside of the immediate household is high (Verver, Warren, Munch, Richardson & Van Der Spuy, 2004.)

It is known that people with the TB disease can infect up to 10-15 people through close contact over a period of a year. Another concern is that when a person develops active TB, symptoms can remain mild and the infected person might not seek help in time. Consequently the infected person will transmit the bacillus while interacting in the community. The risk of fatality due to untreated TB was reported by WHO and one third of people ill with TB might die due to the disease if not treated on time (WHO fact sheet no. 104, 2015). In addition, the transmission cycle of TB is vicious, and will continue if not interrupted. The continues transmission and the risk of transmission in the close contacts is readily known, however research are not documented in Namibia, for the effect of casual exposure, outside of households and the consequent transmission of infection.

1.3 Problem statement

Current emphasis for TB control in Namibia is put on contact tracing for immediate household contacts (MoHSS, 2012). This approach has the potential to miss the transmission outside the household, where community contacts may also be at high risk. The transmission risk of TB might be similar between close and community contacts because of the nature of social interactions and closeness of people in the homesteads.

However, it is known that the risk of transmission of TB is higher among household members who are close contacts of person with infectious TB. Similarly, in high TB prevalence areas, transmission of infection of TB may occur outside the household too. Therefore, contacts in the community may also be important reservoirs for transmission of TB. (Shapiro, Variava, Rakgokong, Moodley & Luke, 2012).

The majority of San people of Namibia are living in poverty, but they also have living arrangements that enhance frequent social contacts and they are co-habiting as a group of 8-15 people in a homestead (Gibson, 2010).They are living in homesteads which consist of several adjacent huts, with doors opening to the same communal area. These homesteads form a settlement that can contain 200 to 300 people (Wilmsen & Denbow, 1999). The density of these homesteads and settlements are in contrast with the population density in Namibia which is 3 people per square kilometre (Namibian Population and Housing census, 2011). Given the mentioned living arrangements of the San people, the density in these homesteads can be considered more congregated then the national density. Furthermore they are living in huts with poor ventilation that can enhance the transmission of the TB bacilli (Gibson, 2010).

While traditional community of San in Tsumkwe is living in a congregated style, they are heavily burdened by TB. Although TB disease prevalence studies have not been done in Namibia, the case notification rate (CNR) for TB in Otjozondjupa region, where Tsumkwe is situated, is 478 cases per 100 000 population. This region however contributed the highest number of MDR-TB caseload to the national MDR-TB burden. Furthermore Otjozondjupa region has the highest caseload for drug resistant TB in the country and one-third of the cases are from Tsumkwe constituency, according to the information obtained from the electronic TB register (ETR-net) (MoHSS, 2014)

San people have a different lifestyle than most ethnic groups in Namibia, suggesting that the national and regional level TB data may not be sufficient to understand their TB burden. Additionally, their unique living arrangements mean that there may be differences in household vs. community transmission compared to other groups. Therefore, this study is important because it measures the transmission risk for TB among household and community contacts in a high-risk group.

1.4 Aim and objectives of the study:

1.4.1 Aim of the study:

The aim of this study is to compare the risk of TB transmission in the households with TB patients with those living in a household without TB patient, but staying in the same homestead.

1.4.2 Study objectives are to:

1. Determine incidence of TB disease among close and community contacts of TB patients.
2. Compare risk of TB disease among close and community contacts of TB patients.
3. Determine the risk factors for TB disease among households with confirmed TB patients and households without TB patients, in the high prevalence rural community of Tsumkwe.
4. Compare the prevalence of infection among study participants from households with confirmed TB patients and study participants from household without TB patients.

1.5 Significance of the study

This study investigates whether the risk of transmitting TB infection from an index case to household contacts is equal to the risk of transmitting TB infection from an index case to other social contacts outside of the household. The transmission risk is examined by comparing the rate of TB disease among those exposed to an index case in the household and the rate among those not exposed to an index case in the household, but living in a close proximity to a source case. A study of this kind has not been documented in Namibia according to the literature reviewed.

The study therefore provides evidence to help determine whether interruption of transmission of infection in the community is equally important as in the immediate households. Subsequently, it will provide a basis to develop appropriate treatment and care strategies in high prevalence areas. Social mobilization activities might be adjusted according to the outcome of the study, for better outcomes and intensifying of contact tracing and case finding strategies.

In summary, the study sought to quantify the proportion of individuals that might acquire infection outside of the household compare to those who acquire inside the household. It further researched the possible underlying risk factors for transmission of TB, such as number and age, sex and number of homestead members, in the community. It will therefore provide a reference point to embark on in-depth studies on the transmission dynamics in traditional closely-knitted households. Further studies can be applied that will make use of genotyping to link index cases and secondary cases.

The findings can be used to determine whether the current focus on household transmission is effective in resource limited, closely-knitted communities or whether a more vigorous effort needs to be tailor-made for these communities of interest. The study will establish the prevalence of infection among those who are from households and homestead with TB cases but are not presenting with symptoms, to determine latent infection and recommend preventive therapy.

1.7 Definition of key terms

The following definitions apply to this study:

Close Contacts: A "close contact" is any person who had close association with a person with infectious TB for a period of time (McGraw-Hill concise dictionary, 2002) For the purpose of this study, close contact is any person who lives and sleeps with a TB patient in the **same hut**, for 30 days and more, before initiation of anti-TB medication.

Community contacts: "Community" means group of people sharing the same physical space and "contact" is any person who has association or communication with others (Webster's dictionary, 2000). In this study community contacts refers to any person who lived with a TB patient in the same **homestead,** for 30 days and more, before initiation of anti-TB medication for the index case.

Household: This term refers to all people living in a given house including servants (Oxford dictionary, 2000). However for the purpose of this study, a household consist of 3-5 people (in exceptional cases more) sharing a hut, sleeping together at night, which is situated in a homestead with other huts**.**

Homestead: A homestead is a cluster of several houses occupied by extended family (Collins dictionary, 1996). For the purpose of this study a homestead is a group of huts arranged in a horseshoe where extended families are living and sharing the same fireplace.

Index case: An "index person" is someone that reference can be made to (Webster medical dictionary, 2000). The definition of an index case for the purpose of this study is a person with confirmed TB disease who is the initial person in the homestead who was diagnosed with TB.

Secondary case: A secondary case is the occurrence of disease in a close contact of a primary case-patient, 24 hours after the onset of illness in the primary case-patient (Webster medical dictionary, 2000). For the purpose of this study the definition of secondary case is a person who develops TB disease after been exposed to an infectious index case.

1.8 Summary

This chapter contained the synopsis of the study. It provided the background of the specific problems of transmission risk of Tuberculosis among a study population with high incidence rate which led to the problem statement; defined the study; and discussed the purpose of the research, as well as the research objectives. The chapter also identified and defined the key concepts used in the study. The next chapter contains the literature review.

CHAPTER 2: LITERATURE REVIEW:

This section provides an overview of the literature that is relevant to the field of study and by doing so, use the available research evidence to make meaning of the study and utilize and analyse research data effectively. Tuberculosis (TB) burden worldwide, in Africa and Sub Saharan Africa, will be explored, the transmission of TB in Namibia will be examined and with a focus on susceptible and drug resistant TB. Tuberculosis transmission in high risk and vulnerable groups will be reviewed, and other dynamics related to transmission will be explored to link to the problem to be research on. The attention will be on the high burdened resource limited, traditionally semi-nomadic society and the TB disease in that given society.

2.1 TB burden globally and in Africa

The World Health Organization reported that in 2013, the largest number of new TB cases was reported in the South-East Asia and Western Pacific Regions; these regions accounted for 56% of new cases globally. Nonetheless, Africa carried the greatest burden, since the number of new cases per population reported was higher compared to the Asian and Pacific region; it amounted to 280 cases per 100 000 population in 2013(WHO Fact Sheet no. 14, 2015).

An estimated 24% of all the global cases during 2013 occurred in the Africa region and TB-related incidence and mortality rates remained high. The HIV epidemic has fuelled the TB infection in sub Saharan Africa. It is a known fact that TB is the leading cause of disease and death for HIV-positive patients. In addition, the people who are living in resource-limited settings are the ones who are plagued with the high burden of TB (WHO Fact Sheet no. 14, 2015)..

Recent research done by Kompala, Shinoni and Friedland (2013) to determine the transmission of TB in high-burdened, resource-limited settings, reported that there are high rates of transmitting the infection to other susceptible contacts in high-burden communities. The undesirable situation is that limitations in contact tracing and diagnosis result in unrecognised transmission of the TB infection. Adversely, the unrecognised transmission can immensely contribute to the ongoing epidemics of TB in resource-limited settings. Another alarming discovery is that the transmission of susceptible and drug resistant TB (DR-TB) is continuing in regions with high prevalence of HIV. The above-mentioned researchers further argue that community settings are accounting for more transmission than household and health facility settings while the importance of household transmission is still not overlooked. Recommendations given, based on the findings of the study, are therefore emphasizing that it is vital to focus on contact tracing and prevention of onward transmission of TB, to yield favourable outcomes in TB control. Infection control is often times neglected and should also be seen as an area to improve on (Kompala, Shinoni, &Friedland, 2013).

2.2 Transmission of Tuberculosis in Namibia

Namibia had the fourth highest TB incidence rate in the world, in 2013 and has joined several countries in reporting DR-TB. The disease is prevalent in all regions of the country with regional variations. The National TB and Leprosy programme (NTLP)is facing challenges such as lack of skilled human resources. However, the programme is working towards achieving the global targets set by WHO, which are reduction of the incidence, prevalence and death rates associated with TB. Of all new smear positive cases that were registered during 2013, a high number of cases (85 %) completed the treatment successfully. The remaining 15% could not complete treatment because of undesirable outcomes such as defaulting (5%), failure (5%), and death (5%) (MOHSS NTLP Annual Report 2012-2013).

Figure 2.1 shows the trend in the number of all forms of TB notified over a 10 year period, 2002 till 2012 in Namibia. A decline in TB incidence in Namibia was observed since 2008, never-the-less TB is the third cause of hospitalization in Namibian hospitals and the country is among the countries with the highest per capita burden (MOHSS NTLP Annual report 2011-2012).

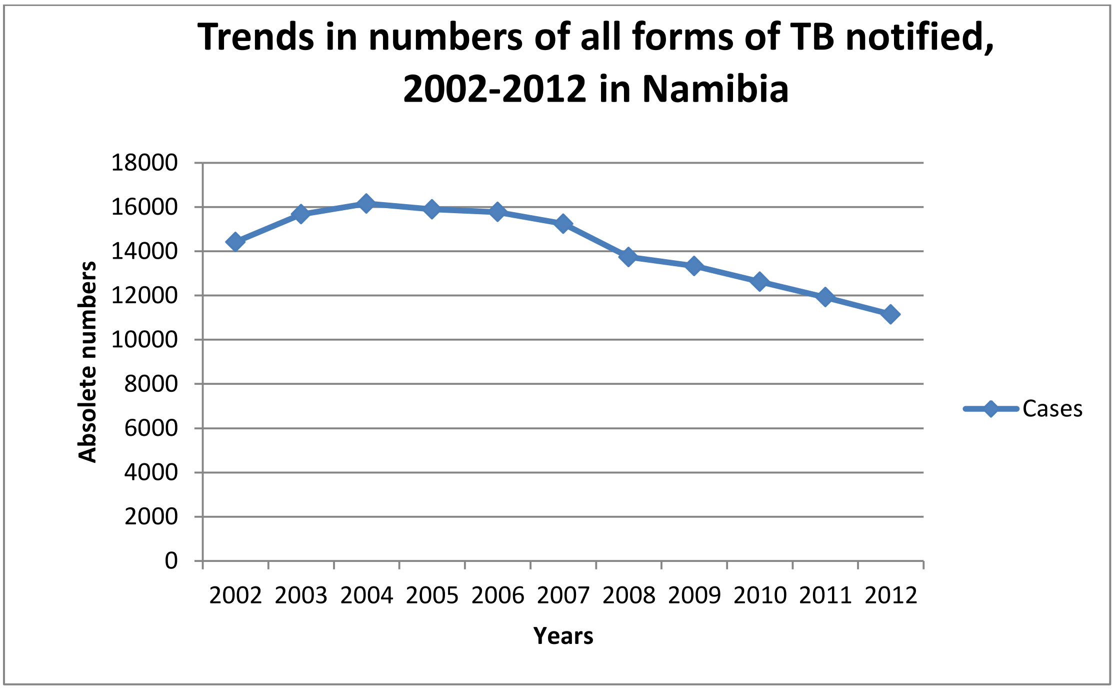


Figure 2.1: Trends in the number of TB cases notified over 10 years.

On incidence and spread of the disease, from all new cases reported during 2012 11% were children aged 0-14years. This national estimate falls in the bracket that was established by a study done by Ramos and others, which was found to be 3% to 25%. In extreme cases, where poverty and overcrowding is dominant, as was the case in South Africa, it can rise to 39% (Ramos, Reyers, & Tesfamariam., 2010). Although the incidence might not appear very high, it is in itself an undesirable occurrence because they are the most vulnerable group in the society, and need to be protected.

2.2.1 Drug resistant-TB in Namibia

Drug resistant TB is defined as the resistant of the TB bacilli to the most common anti-TB medicine. The most threatening forms of resistant TB are the Multidrug resistant TB (MDR-TB) and the more extreme form, extensively resistant TB (XDR-TB). Multidrug resistant TB develops due to resistance to the two most commonly used medicine (isoniazid and rifampicin) for first line treatment for susceptible TB. Extensively drug-resistant TB (XDR-TB) emerges due to resistance to fluoroquinolone and at least one of three injectable second line medicines (CDC TB fact sheet 2015).

While absolute numbers for DR-TB patients are known, the incidence among contacts is not always known. However a study in South Africa, to determine the incidence rate of DR-TB among contacts of index cases, found that incidence of MDR-TB and XDR-TB was extremely high among the close contacts. Many of the secondary cases were presenting themselves shortly after the diagnosis of the index cases. The median time recorded to diagnose a secondary case was 70 days (Vella, Recalbuto & Guerra, 2011.)

Literature outside of Africa also indicated informative results on the transmission of DR-TB. A study was conducted in Peru by Cohen and his colleagues (2012) to estimate the frequency of the introduction of DR-TB into households. One of the key findings was that the risk of extra-household or community transmission of DR-TB was high compare to the household transmission, in Limu, Peru (Cohen, Murray & Abubakur, 2012).

While many industrialised countries have reported emergence of drug resistance TB, some countries in sub-Saharan Africa started to report on drug resistant TB as from the early 1980's. Researchers in South Africa have used molecular epidemiological studies to understand the MDR-TB epidemic in South Africa. These epidemiological studies found that low case detection and delay in diagnosis are driving the drug resistant TB epidemic in South Africa. This has result in the amplification of Multidrug resistant TB and the consequent emerging of extreme drug resistant TB (Streicher, Muller, & Chihota, 2012).

Fairly, Beylis and Reubenson (2011) conducted a retrospective analysis of the prevalence of MDR-TB in children with Mycobacterium Tuberculosis in two hospitals in Johannesburg, South Africa. There were variations among the mono and multidrug resistant patterns, but the overall multi drug resistant TB prevalence in the children on which drug susceptible testing (DST) was done was 8.8%. These children were initially culture-confirmed mycobacterium TB patients but were diagnosed as MDR-TB patients after drug sensitivity test (DST). The results of this study hint a large burden of undiagnosed MDR-TB in this given community. Many household and community contacts of these children are undiagnosed and are the source of ongoing spread of the strain of TB that is difficult and costly to treat (Fairly, Beylis & Reubenson, 2011).

The risk of transmission of drug-resistant TB outside of the household was documented by Leung and Kam (2013) in a European study. While MDR-TB is found to be transmitting more often in the household, because of its long infectivity, XDR-TB transmits largely outside of the household. Given the complexity of DR-TB treatment these facts should be considered in all activities of TB control (Lueng, Lueng, & Kam, 2013).

A study done in Namibia to describe the epidemiology of MDR-TB in Namibia and the risk factors for developing drug resistant TB indicated that previous treatment, previous hospitalisation, and exposure to a household member with drug resistant TB were associated with MDR-TB in Namibia. The same study has also reported evidence of transmission of drug-resistant TB in the household as well as in the community (Ricks, Mavhunga, & Modi, 2012).Difficulty in accessing appropriate TB treatment for susceptible TB and in following up of TB patients is linked to the developing of Multi-drug resistant TB as well. That might be one of the reasons why MDR-TB is prevalent among the socially-neglected communities and the spread is difficult to contain.

The National TB and Leprosy Programme (NTLP) continued to follow international protocols to treat patients with DR-TB successfully. The cohort of DR-TB patients treated during the 24-month period of 2010-2012 indicated a 58% treatment success rate. This rate was significant higher than the previous cohort. The death rate of 17% and the defaulter rate 20% are, however, an immense concern. See figure 2.2 for the treatment outcomes of MDR-TB.

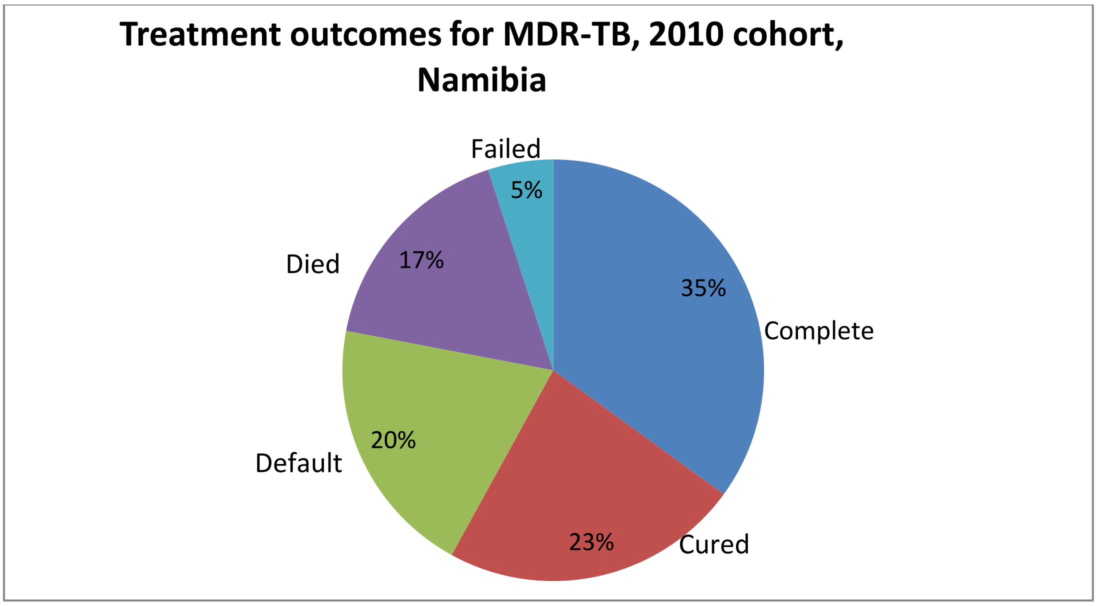


Figure 2.2 Treatment outcomes of MDR-TB patient treated during 2011-2012 in Namibia

Regional data on drug resistant TB prevalence show that Otjozondjupa region has the highest number of DR-TB patients in the country. The San community is residing in this region and MDR-TB is prevalent among the marginalised San community of Tsumkwe constituency. The district data indicate that 30% of cases are from Tsumkwe and surrounding villages; that constituency is contributing close to a third to the regional totals. The treatment success rate for this region for DR-TB is 55% and the remaining 45% is representing undesirable outcomes such as failure, death or defaulting. Hence, this region can be seen as a ‘hot spot’ for DR-TB in Namibia.

2.3 Transmission of TB in high-risk populations:

High risk groups are found all over the world and among them are drug and alcohol users, homeless people, the unemployed and marginalized, and nomads. Malakmadzi and colleagues (2005) conducted a study in Wisconsin state, United States of America (U.S.A) to detect unsuspected transmission among high-risk groups such as drug and alcohol users and homeless, unemployed people. They found additional contacts of TB cases that were positive during their study. These additional contacts were missed during routine contact investigation. They concluded that infected contacts might be left undetected and contribute to ongoing spread of infection. The results documented by this study agree with other studies that transmission, especially in high-risk populations, might be unrecognised and on-going. The undetected contacts of cases can fuel the general problem of tuberculosis (Malakmadzi, Gonzalez & Oemig,2005).

The scale of undiagnosed and ongoing transmission of TB cannot be measured at a quick glance. However studies are ongoing to tap into those unknown areas. A study was done in Philippines (2010) to determine the magnitude of undiagnosed TB among household members and to establish the socio-demographic factors associated with it. The results of the study corroborate those of previous studies which highlighted the persistent challenge of undiagnosed TB among household contacts. The study documented the prevalence of TB disease among household contacts as 12.8%, and 65.6% of contacts examined had TB infection. The researchers have therefore recommended that tracing of contacts and early diagnosis of TB in low and middle income countries with high prevalence of the disease should be a priority (Sia, Orillaza & Sauer, 2010).

The transmission of TB among household members remains a reality but the timely diagnosis and treatment of TB is not always attained. A recent community-based study done in South Africa (2012) underscored the risk for household transmission of TB and undiagnosed disease that is prevailing in communities. The study found that the prevalence of undetected TB among contacts of households with recently diagnosed TB patients were very high compare to members from household without known TB patients. The prevalence of infection among contacts of TB patients were 6075 per 100 000 while the prevalence among those from households without TB patients was less than 500 per 100 000(Shapiro, Variava, Rakgokong &Moodley, 2012). The finding of this study relate to the fact that the households are still the danger zone for TB transmission worsen by the threat of undiagnosed TB disease and infection.

Undetected TB has the frightening consequence of continuous spread of the organism to contacts of the undiagnosed persons. Ongoing spread of the TB disease remains a significant phenomenon across the world. Devline and Passmore (2013) reported in a public health bulletin the ongoing transmission of TB in an indigenous community in Wales. New cases have continued to emerge despite of TB control measures that were implemented. Reasons cited as the possible causes of the persistent spread of TB, were the broad social networks people were maintaining and also the extremely mobile lifestyle of indigenous traditional societies (Devline & Passmore, 2013). The already referenced fact that the undiagnosed cases can contribute to the escalation of the TB burden in the community are further underscored by the evidence of the study.

As per previous study findings, undiagnosed TB infection is cited as major contributor to the ongoing epidemic of TB especially in high epidemic regions. While the sources of this undiagnosed infection is not readily known, two separate studies conducted in the neighbouring South Africa, one by Verver in 2004 and one by Middelkoop and colleagues in 2014, suggested the high risk of TB transmission of TB outside of the household. This undiagnosed disease in the community could provide a hazardous reservoir for the spread of the disease, hence the uncontrolled spread in the community (Verver, 2004; Middelkoop, 2014.)

Undiagnosed TB disease can contribute to the transmission outside of the household. Buu and colleagues (2010) undertook a study in Vietnam to assess TB transmission within and outside the household. The results suggested that TB transmission in the community was higher than in the household. The researchers of the mentioned study argued that even if one would assume that processing errors could cause some discrepancies, the proportion of infections found outside of the household would be 77%. Although the researchers did not exclude the possibility that the different strain that was found in household members could be from another source in the household that was not diagnosed and captured, the finding suggest that for the study population, most cases was a result of infection outside the household. Noteworthy; the latter results are similar to observations in high prevalence areas in South Africa and Gambia and Malawi (Buu, Van Soolingen, & Huyen, 2010).The finding of this study argues that if contacts tracing is only geared towards immediate contacts in the household than intervention might miss the community contacts. Yet a broader, intensified case finding could be more appropriate.

The progression of infection to disease can be influenced by environmental as well as host factors. While environmental factors such as poor living conditions and overcrowding add to the spread of the disease, host factors that impair the defence mechanism to fight the infection and the disease, such as poor nutrition and HIV infection, contribute to the risk of progression from TB infection to TB disease in vulnerable groups (Lonnroth, Uplekar,Arora & Juvekar, 2009).

Additionally, factors that hinder the access to health services, which provide diagnosis and treatment of TB, such as economic barriers, cultural barriers, geographical barriers and health system barriers worsen the TB problem. However, the macro-level factors that have the greatest influence on ill-health and disease are biological, socio-economic and environmental.

Figure 2.3 below explains the interaction of these factors and consequent vulnerability.

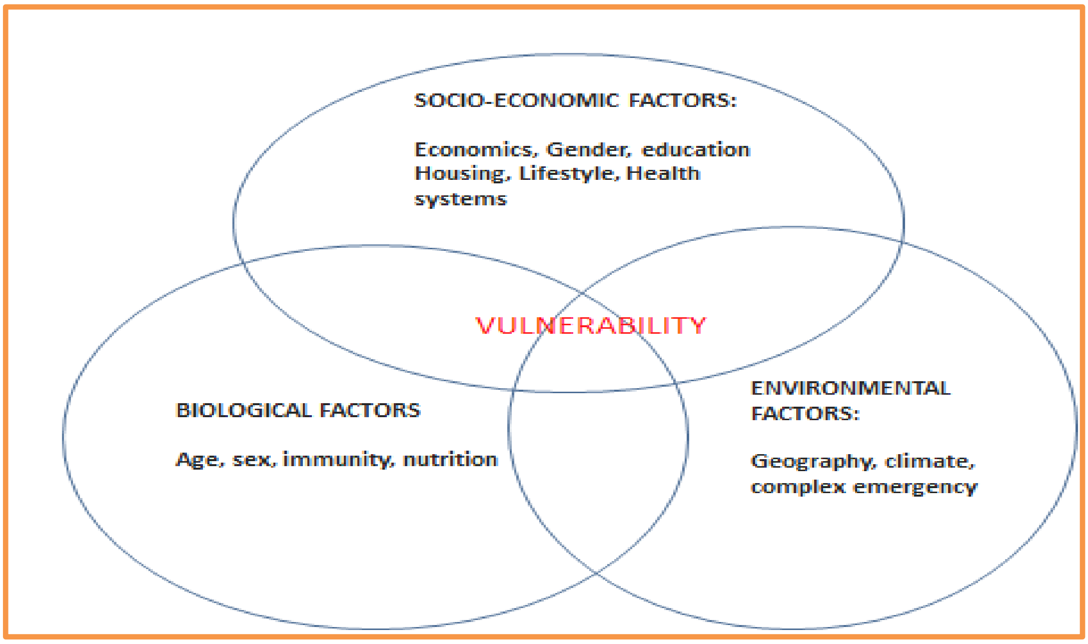


Figure 2.3: Factors associated with ill-health, Source: Adapted from Bates et al (2004).

When vulnerable groups such as children or young adults acquire TB it is straightforwardly assumed that they acquired TB from adults such as parents, caregivers, and older siblings. Marais and others (2009) conducted a study in South

Africa to confirm household transmission of TB from adults to children. Less than the half of the adult index cases had the same strain with the secondary cases; the findings therefore indicated that young children have a risk of being infected in the household as well as in the community (Marais, Hesseling & Schaaf, 2009).

Though the parents are often regarded as the source of infection for children, frequently the source of infection is questioned; whether the source of infection should be tracked back to cohabiting contacts or social ones. The research done in South Africa in 2014 had more compelling evidence on the risk of TB transmission outside of the household. The purpose of the research was to explore the relationship between exposure to infected adult and the risk of infection. The findings concluded that while risk of infection is attributed to infected adults in the household, the infection in adolescents was not due to residential exposure. Adolescents are found to socialise more than the younger and older population and exposure to infection could be from multiple sources. This finding further underscored the relevance of determining where the risk is for any given risk group (Middelkoop, Bekker, & Murrow, 2014).

Confined social gatherings places visited by mobile infected persons could possibly be enhancers for transmission of TB bacillus. A study done by Murray and colleagues (2009), using geographic information system (GIS), found high clusters of cases in high-risk areas outside of the households. Social gathering places such as alcohol drinking places were indicated as high-risk areas. A strong association of TB incidence and unemployment, overcrowding and number of social networks, was found (Murray, Marais & Mans 2009).

While geographic information systems were used to trace transmission sites of TB, other studies have used molecular genotype testing to link source cases with secondary cases. The results of a molecular study that was conducted in Malawi have demonstrated that 44% of cases could be linked to household and family contacts while 19% was from other contacts different from the household contact (Crampen, Glynn, Traore, Yates &Malcolm, 2006).

In the abovementioned study the percentage of household transmission was higher than outside the household, which was in contrary to other studies, but is still emphasising the risk in the household. Notwithstanding the mentioned, given the results of various studies, transmission of TB in many cases cannot be attributed to household contacts only, especially in high incidence settings. Evidences provided by these studies accentuate importance of contacts tracing outside of the household.

2.4 TB incidence in nomadic, vulnerable communities

Nomadic and vulnerable people are more often at risk of diseases and ultimately communicable disease. Understanding the incidence and risk of TB transmission in isolated and vulnerable communities appears to be troublesome. The occurrence of

TB in vulnerable communities, in which the disease is difficult to detect, diagnose and treat, results in severity of disease, mortality and spread in the community, and eventually poses a serious challenge to curb the impact of the disease. Furthermore, the socio-economic situation of these communities resulting in poor living conditions, overcrowding, and limited access to health care aggravates this situation.

The study done in Iran by Honarvar (2014) to detect pulmonary TB in nomads, found that TB incidence among nomad communities was nine times higher than in the general population. This evidence indicated that National TB Programmes (NTP's) and other health services should be particularly cognisant of the health needs of the vulnerable communities, when it comes to communicable diseases such as TB (Honarvar, et al., 2014).

Displaced and vulnerable groups such as immigrants, homeless and illiterate people in industrialised communities are also facing the same challenges as indigenous nomad communities. As a result, deprived and marginalised people create a serious challenge for TB control worldwide. The association between TB and poverty facilitated by the consequences of poverty such as poor social capital, overcrowding, homelessness, poor ventilation in homes is universal when it comes to TB control. The perception of these vulnerable people on health and disease, and their help seeking behaviour are also influenced and modified by their pressing social problems. Their perception of health and disease and their perceived self-efficacy to seek help on time can be altered in a negative direction (Figueroa-Munoz &Ramon-Pardo 2008).

Vulnerable groups are not only susceptible in the sense that they are prone to disease and other ailments. Since they are often exposed to congregate settings, their exposure to people that they are deliberately or unintentionally interact with, put them at more risk. They can therefore be exposed inside or outside of their households. However the general perspective is that TB transmission is more prominent in the household (Whalen, Zalwango, Chiunda, Malone, Eisenach, Joloba, Boom, & Mugerwa, 2011)

Claassen and colleagues (2013) supported findings of other studies on TB transmission outside the household. The results revealed in a study concluded in South Africa that among high-risk vulnerable groups, transmission can take place outside of the household (Claassen, Van Schalkwyk & Den Haan, 2013). The findings do not defeat the importance of household contact tracing and investigating, but draw attention to the broader threats posed by casual contacts to prevention and control efforts. The coherence with established facts that TB transmission is not only limited to the confined environment, highlights the need for dedicated investigation in a specific high-risk community of interest, such as the marginalized, vulnerable San community in Namibia.

A prospective study was done by Radhakrisna and Frieden (2007) over a period of 15 years, in a rural community in India to assess the risk of contacts of TB cases. The risk was found to be higher in contacts of smear positive pulmonal TB case but what is of interest to this study is that a meagre 8.5% of the incidence was from household with TB. The findings suggest that although family contacts have a significant higher risk, the contribution to the new caseload is not that high (Radhakrisna, Frieden & Subramani, 2007).This findings inform that community contacts contribute significant numbers to the caseload. This can be explained by the fact that index cases have more outside contacts than inside ones.

Cook and others (2007) conducted a social network analysis with TB transmission data. They used the approach to establish whether this approach can detect patterns of mycobacterium TB transmission. The places of social aggregation of TB patients as well as their contacts were studied too. Correlation was found between TST positivity and attending dense social aggregation. The study suggests that skills for social network analysis should be developed and a social network analysis carried out. This will enhance better use of case investigation data and help in prioritising case investigation sites (Cook, Sun, Tapia,Muth, Arguello, Lewis, Rothenberg, & McElroy,2007).

The role of social networks was also discussed and argued in a study by Wood, Racow, Bekker and Morrow (2012). The study was done in South Africa in a high

TB burden community. The above-mentioned researchers hypothesised that TB infection is mainly acquired indoors and the potential for transmission is mainly determined by the number of social contacts a person meet. The duration of time spend in a transmission-conducive environment is also a determining factor. Therefore the time spend with social contacts, the number of social contacts met in indoor locations, and the use of public transport was quantified. The study concluded that people have more social contacts during childhood, adolescence and young adulthood and these interactions take place in schools and during use of public transport. The non-home social networks of the young population were found to correspond with increase in TB infection in this high burden community and age was associated with acquiring TB infection outside the household (Wood, Racow, Bekker &Morrow 2012). This evidence underscores the role that social networks play in the transmission of TB.

The general transmission of Tuberculosis is important but what remains a bone of contention is the spread of the drug resistant (DR) strain of TB. The burden of resistant TB that is spread in household is a serious challenge for an overburdened TB programme. Notwithstanding the immense efforts in terms of finding treatment options for resistant TB, the low prognosis of patients suffering of drug resistant TB in poverty-stricken resource-limited communities can easily divert positive health gains. The results of the study conducted in (2011) by Beracco, Appleton and Franke highlighted the fact that incidence in households of MDR-TB and XDR-TB was the same but the frequency of active TB was nearly two times higher in households with

XDR-TB than it was in contacts of MDR-TB. In short this study recorded a high risk of TB transmission among household contact of resistant TB, especially XDR-TB (Becerra, Appleton & Franke 2011).

The same researchers Becerra, Appleton and Franke (2013) recorded findings of another study of children who are sharing a household with drug-resistant (DR-TB) TB patients. The results indicated that children in households with resistant TB have disease rates 30 times higher than in the general population. The disease rates for those older than 1 year were not significantly higher than the adult population, but the overarching concern is the chronic exposure of young children to an infectious patient. It is therefore worthwhile that the current study look additionally to the proportion of contacts of resistant TB patients who develop active TB (Becerra et al 2013).

2.5 Transmission dynamics of Tuberculosis

The general knowledge is that TB can effortlessly be transmitted in confined settings where ventilation and sunlight are insufficient. The risk is recorded as high in contacts of microscopy smear positive patients with pulmonal TB based on knowledge drawn for literature. Prevalence of TB among the contacts of TB cases with pulmonal TB was found to be high compare to the contacts of extra-pulmonal

TB (ETB) patients. Poor immune system and poor nutritional status are additional risk factors for TB transmission too (Claassen, et al 2013).

People living in high-risk populations, such as the homeless, unemployed and substance abusers are exposed to unrecognised infection. The unrecognised and undiagnosed transmission adds to the ongoing spread of the disease. Age and mobility are associated with ongoing transmission of TB in communities according to findings of studies conducted. On the other hand ongoing transmission becomes a challenge among the highly mobile youth that congregate around confined places (Middelkoop et al, 2014).

Casual exposure to TB outside of the household is often not talked about, but literature reveals that transmission in the community is real. Three studies done in South Africa (Fairly et al.2011,Streicher et al.2012, and Middelkoop et al.2014), one in Malawi(Crampen et al. 2006) and one in Vietnam (Buu et al.2010) point out explicitly that transmission can take place outside of the immediate household and family setting. The findings were authenticated by molecular genotypic linking of patients and contacts. Therefore this research will use the conclusions drawn from this literature to understand the findings of this study.

2.6 Summary

This chapter discussed the literature reviewed for the study, focusing on TB in high-burden regions as well as in high-risk populations and nomadic vulnerable communities. It also highlighted the risk of transmission in the immediate household as compared to the broader community. The link between poverty and the TB problem in general was explored and described. The next chapter discusses the methodology and research design.

CHAPTER 3: METHODS AND RESEARCH DESIGN

3.1 Introduction

This chapter presents an in-depth analysis of both the design and methodology of the research. The location and study population are described. In addition, the sampling strategy and data collection procedure and tools are outlined. Furthermore, techniques used for data management and analysis as well as ethical considerations pertaining to this study are discussed in this chapter.

3.2 Study design

A retrospective cohort study was conducted of the close and community contacts of TB patients. The cohort study determined outcomes (TB infection or disease) after prior exposure to a TB patient the household or in the same homestead. The exposure factor was exposure to the TB patient and the outcome was TB disease or no disease.

The risk of TB disease and infection in households with TB patients was compared with the risk in households without TB patients in the same homestead. The exposed group was people who were living with a TB case for more than 30 days before treatment and the unexposed were those who were not living in the same house with a TB case but in the same homestead. The cohort study provided the opportunity to compare the outcome, which is the TB disease and infection, among those who shared a home with TB patients and among those who did not shared a home with a TB patient.

The close contacts and community contacts that acquire TB infection and disease were quantified. Close contacts were sharing a household and community contacts were sharing a homestead with the index case. Comparison between close and community contacts with TB infection and disease, were made. A quantitative research method was therefore used.

With quantitative research the data collection process was less time consuming because structured questionnaires was used. The field promoter who was assisting the researcher could easily understand and interpret the questionnaire. The data tools for quantitative research were user friendly and data collected, could allow for quantitative predictions to be made. Data analysis was easy too, because data could be entered in statistical software and summary reports could be given in numerical terms. In summary when data analysis and reports are given in numerical terms the findings can be given with a specified degree of confidence.

The measure of association used to quantify the relationship between exposed and unexposed was relative risk. The likelihood for the exposed to have the TB disease and infection was compared with the likelihood of the unexposed to have the disease and infection.

3.3 Study population

The study population comprised all close and community contacts of TB patients from the catchment population of Tsumkwe clinic. The catchment population of Tsumkwe clinic is 9900 people.

3.4 Sample strategy

The study participants were conveniently sampled because of their availability at the time of the study. Convenience sampling is a type of non-probability sampling in which people are sampled because they are a "convenient" source of data for researchers (McGraw-Hill dictionary, 2002.).

The cohort that was recently registered and treated, during calendar year 2014 was used as the index cases. The total index cases (56 patients) registered during 2014 (56 patients), close contacts (66 people) and 102 community contacts were selected for inclusion. Out of 56 index cases 34 index cases were selected from 23 homesteads. Nine homesteads had more than one index case.

The homes of 34 out of the 56 index cases were visited; those visited were from 23 homesteads. Since it was difficult to identify contacts of patients from the more distant past and in order to reduce recall bias a recent time period (one year retrospective) was chosen. The index cases that were selected through convenience sampling were interviewed to collect data on their demographic characteristics and to establish the number of contacts. The health facility TB register was used as a source to identify the index cases and their relevant contacts.

The close and community contacts of the index cases were then purposively sampled. The contacts of the index cases were identified by the index case as their contacts, and were in close proximity (200-300m) to the index cases

The exposed group was close contacts of index cases registered, both smear positive and smear negative patients. The unexposed group consisted of community contacts, defined as all people living in the same homestead with the exposed group but not living with TB patients in the household. Household members are defined as all people sharing the same hut in the same homestead.

Since the huts are arranged like a horseshoe in the homestead the 2^{nd} or 3^{rd} hut was sampled for the interview. The hut for the comparison group was thus conveniently selected based on the availability of the household members at the time of interviews. The average number of close and community contacts was 6 for the homesteads.

3.4.1 Inclusion criteria

The following persons were included:

- Close contacts: these are persons, who were living with someone with TB in the same household for more than 30 days in the past year. This is because incubation period of TB bacillus is 4-12 weeks. Therefore the minimum of 30 days was taken.
- Community contacts: these are persons living in a household without TB patients. This person has lived in the same settlement with TB patients for the past year (2014), but not in the same households with persons diagnosed with TB or who had signs and symptoms.

3.4.2 Exclusion criteria

The following persons were excluded:

- Close contacts who had signs and symptoms or who were diagnosed with TB before entering the specific households.
- Community contacts who had TB before or lived with a TB case in the household, or had signs and symptoms before entering the homestead.

3.5 Data collection procedure:

The data were collected over a period of 8 months, from February until September 2015. During data collection process the following aspects were considered: study location, data tools and the data collection methods.

3.5.1 Study location

Tsumkwe clinic in Grootfontein district, Otjozonjupa region was used as the entry point of the study; the research took place in the central area of Tsumkwe constituency. The clinic was a convenient entry point to meet the patients and their respective contacts. Additionally the clinic is the only primary health care facility for the Tsumkwe constituency and referrals are made via Mangetti Dunes Health Centre which is 100 km away to Grootfontein District Hospital which is 300km away.

The constituency consists of close to 30 villages but only the villages from where the index patients were coming, which was registered for treatment during 2014, were chosen. The catchment population consists of Tsumkwe settlement and surrounding villages. The following villages were visited for data collection purpose: Tsumkwe settlement, as well as one village north of Tsumkwesettlement (//Xa/oba), two villages west (Kaptein post, Duinepos), three villages east (Ben se kamp, //Auru, #Nama pan) and one in a close proximity to Tsumkwesettlement (Mountainpos). Figure 3.1 presents a map of Tsumkwe and the surrounding villages, with the villages that were visited circled in red. These villages were selected because of feasibility and the time frame of the study.

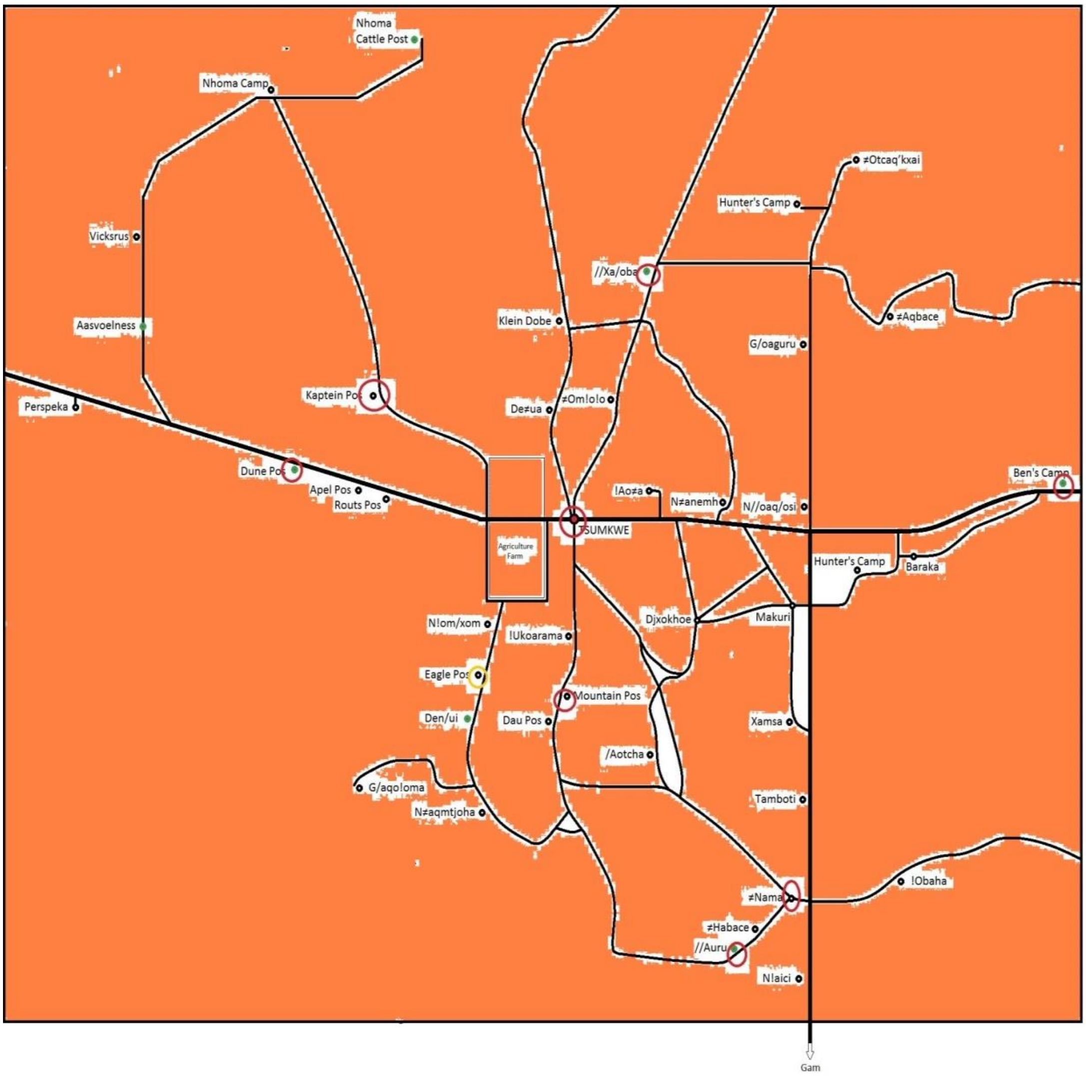


Figure 3.1: Map of Tsumkwe settlement and surrounding villages.

Tsumkwe settlement is remote and is situated 502km away from the regional capital, Otjiwarongo. It is difficult to reach the remote communities because the road network is gravel or sand, and common game species such as elephants are roaming on the roads. See figure 3.2 for the road network for Tsumkwe and the surrounding areas.

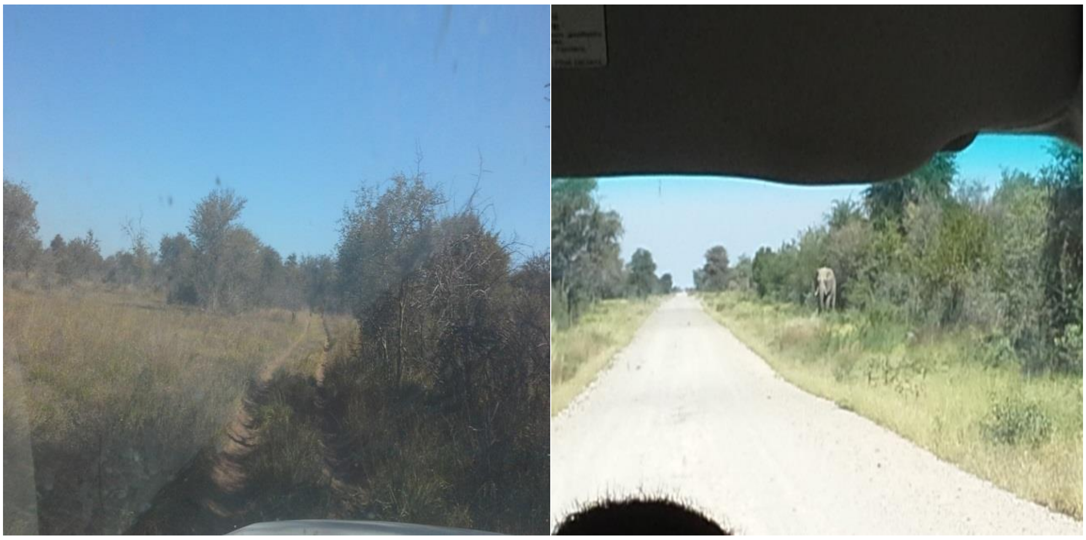


Figure 3.2 Road network of Tsumkwe constituency

The remoteness and geographical design of the area poses special challenges for this community, in terms of access to medical care. Inhabitants of this area do not own means of transport and can only reach health services by foot or hitch hiking. They are not employed and do not have any monetary means to facilitate their travel. The clinic does not have additional transport except for a pick-up that is used to transport referrals to the health centre or the district hospital. It was therefore vital to carry out a study of this nature in this community to have a better understanding of problem faced by these people.

3.5.2. Data collection instruments:

Close and community contacts were interviewed and screened using a structured questionnaire, consisting of close-ended questions. The questionnaire was structured in the following sequence: Demographic information, Health history obtained, Screening questions, results of test done, and consent.

Responses to the screening questions were captured on the questionnaire. The algorithms on screening of close and community contacts were followed to screen and classify the contacts (See Appendices 3a page 105 and 3b page 106). The information for those tested positive or negative for latent infection was noted on the questionnaire as well.

The following demographic information of the patients was captured: registration number, residential address, age, sex, and the date on which the patient started treatment. The questionnaire was piloted using two households in Tsumkwe settlement.

3.5.3 Data collection and data collection methods

Structured questionnaire with close-ended question was used for data collection.
Close and community contacts were interviewed and screened for responses to determine whether they suffered from disease or not. The Tuberculin screen test was

done to detect infection and the results recorded on the same structured questionnaire.

Information on all TB patients registered in Tsumkwe clinic during 2014 was retrieved from the TB register. The following demographic information of the patients was captured: registration number, residential address, age, sex, and the date on which the patient has started treatment. Those patients who were still on treatment were met at the clinic and those who had completed treatment were visited at their homes. The researcher introduced herself to the patients and also to those who had completed treatment and explained the purpose of the research to them. They were informed that they are participating in this research on a voluntarily basis and that they can withdraw from the research any time they want. Thereafter, the index cases identified their contacts. All the potential study participants were visited by the researcher through consultation with the index cases and the registered nurse that was working at the TB room at Tsumkwe clinic. Permission to conduct the research was also obtained from the heads of the households via the interpreter.

The contacts of the index cases were interviewed. Few study participants chose to be interviewed in the presence of index cases. The household member of the comparison group was interviewed at their huts. The researcher led the interviewing process, made notes of any ambiguities and verified with the translator and health worker at the clinic. She was assisted by two field promoters, one of whom helped to identify households and the other, who was a San-speaking person, served as an interpreter for the San people living in villages of study. Afrikaans-speaking study participants were interviewed in Afrikaans by a native speaker. Both field promoters worked in the TB treatment room at Tsumkwe clinic under the supervision of the registered nurse who was responsible for TB outpatients. There, the field promoters provided patient support and health education for more than a year. However the two field promoters were trained on the research tools and data collection process one week prior to the interviews. At the end of each day the researchers reviewed and corrected all the questionnaires with the assistance of the translator.

3.5.3.1 Data collection methods:

Both the contacts from the household member with TB disease as well as those from households without TB disease were:

- Interviewed to collect demographic information, signs and symptoms, exposure and risk factor information (such as type of dwelling or number of household members) using the structured questionnaire.
- Screened with the 5 screening questions (e.g. coughing for more than 2 weeks, fever, night sweat, weight loss, loss of appetite)for signs and symptoms of TB, if not previously diagnosed and signs and symptoms were present then sputum examination, was done and results could be received after 4-6 weeks. The field promoters, who were translators during the research, facilitated the sputum collection process. The patient that was living for less than 30 days with the index case and presented with signs and

symptoms was referred for contact tracing. All study participants with symptoms but with negative smear were referred to a doctor for confirmation.

- The participants from a household without a TB case, found positive were defined as **community contacts.**
- Tuberculin Skin Test for infection was done for study participants who did not present with symptoms or who were not diagnosed with TB, to determine the prevalence of infection among the contacts in households with persons with TB disease and infection among household members in households without TB patients.
- Parents and guardians of underage children, below 18 years, were interviewed on behalf of the children. The interpreters were introduced to the questionnaire and received training for the study (including ethics) beforehand.

The headman of the community was informed about the research. At least 2-3 visits were made to each homestead to collect the relevant data. The first visit was for the researcher to introduce herself to the household members to map the homesteads and huts. The subsequent visits were for data collection and to do Tuberculin skin test (TST) for the asymptomatic contacts and comparison group.

The names of the study participants were linked to the clinic registration number as well as to the unique identifier of the index case. The unique identifier was made out of the 1st two letters of the village and the clinic registration number. The names of study participant were kept separately by the researcher and all links were destroyed after the data analysis process for confidentiality.

3.6. Data Analysis

All the questionnaires were reviewed and coded with predetermined codes, indicating village name and registration number of the patient. The flow diagram which displays an algorithm with inclusion and exclusion criteria was used for sorting the questionnaires (see Appendices 3a, page 105 +3b, page 106). A data entry form was developed in Epi Info 7 and the completed and corrected questionnaires were sorted and the data entered in Epi Info 7.Defined limits were set for data entry, especially for continuous and nominal data

An electronic file was developed and the questionnaires were used to verify the electronic file for missing or incorrect data. A frequency table was run through Epi Info 7 for all variables to detect mistakes and missing data. All missing and incorrect data were checked with the questionnaire and corrected.

The next step in the data analysis plan was to review the study objectives to determine how the data could be used to get the required output. The first objective was to determine the incidence of TB disease among close and community contacts.

To create a baseline for the data, the sex and age distribution of the index cases were presented in a table. The numbers of index cases who were HIV positive and negative were presented in a pie chart. The case fatality rate was calculated as a percentage. A descriptive analysis of the close and community contacts was done and the numbers of exposed and unexposed were cross-tabulated with the number of members of the homestead in a 3-variable table. The number of dwellings in homestead and the average family size as well as the contacts positive for infection were displayed with a table. Family size and homestead density could be risk factors for transmission; therefore the afore-mentioned variables were important for analysis.

The proportion of exposed household members that was diagnosed with TB and the proportion of unexposed diagnosed with TB were cross-tabulated by village of origin. Bivariate analysis was done with the risk factor variable the 'number of household members' and those who was diagnosed with TB in the exposed and unexposed, and presented in a table.

The second objective of the study was to compare the risk in close and community contacts for disease. A two-by-two table was created and exposed with disease and unexposed with disease was computed. The same contingency table was used to determine the risk of latent infection among those living with a TB patient in the household, with the risk of latent infection among those living with a TB patient in the same homestead but not in the same household. Crude relative risk was calculated to determine whether the risk of infection and disease is higher in those living with a TB patient in the household compared to those who are living in the same homestead with the TB patient. The confidence interval for the relative risk was computed to determine the range. Confidence intervals were used as the test for statistical significance.

Age, sex and homestead density can be possible confounders. These variables vary between those living with a TB patient in the household and living without a TB patient in the household. Using the adjusted relative risk, the analysis controlled for age, sex and homestead density.

The third objective was to compare the prevalence of infection among the study participants with TB in their household with the study participants without TB in their household. Prevalence measures are often used to determine the impact of a certain disease in a community and to plan for health care needs accordingly (Henneken & Buring, 2013). It also mirrors the magnitude of the problem and measures the infection status in the community. The numerator was the number of close and community contacts with infection and denominator the total number close and community contacts. Proportion of the exposed with TB disease and infection and proportion of the unexposed with the same was determined and express in percentages. Confidence intervals for the proportions were calculated.

3.7. Reliability and Validity

3.7.1 Reliability

Reliability refers to consistency or dependability of a measure (Maree, 2010).The data collection tools and algorithm for selection of study participants were circulated for expert inputs. No expert feedback or changes were proposed. The pilot testing was done to determine the consistency and accuracy of the tools..

3.7.2 Validity

Validity refers to the degree to which an instrument measures what it intends to measure (Maree, 2010). To ensure validity, the data tools were submitted to two supervisors for evaluation against the study objectives. The data collection tools were also submitted to the research management unit of the Ministry of Health and Social Services to be approved together with the research proposal. The same screening questions that are used in clinical practice to diagnosed TB were used in the questionnaire. The interpreter was trained on specific terms and the structured questionnaire.

3.8 Ethical consideration:

Ethical approval for the study was granted by the University of Namibia (UNAM) and the Information Management and Research Unit in the Ministry of Health and

Social Services (MOHSS). Approval was sought from the regional and constituency authorities and the chief of the villages of study to conduct the study in the communities of interest.

3.9 Ethical principles

3.9.1 Respect for person: and non-maleficence

The study participants were approached with respect and courtesy and the researcher ensured that the study participants understood the purpose of the study, their right to voluntarily informed participation as well as confidentiality. For children who are household members, parental consent was requested and assent from children older than 7 years, as well. Consent and assent forms were developed and study participants were encouraged to sign consent/assent forms. Most of the study participants opted to give verbal consent; they had an open trust relationship with the researcher and the translator because of their engagement with the health system.

3.9.2 Beneficence

Both exposed and unexposed with positive sputum results or signs and symptoms of TB or any other ailment were referred for treatment to the clinic. Study participants with positive skin test were referred for possible prophylaxis.

The researcher opted to visit the homesteads in the morning. The health workers at the clinic advised the researcher that the best time for visits were early in the day, to capture the maximum number of study participants. The early visits were done because of the high mobile nature of the San people. The researcher made an effort to complete the interviews on the same day in each village, to eliminate any biases, and only came back for the Tuberculin skin test and to verify data.

3.9.3 Confidentiality and privacy

Questionnaires were coded with unique identifiers to ensure confidentiality. The two field promoters that assisted with translation and identification of patients were informed of professional secret keeping, and reminded of the agreement they signed with the Ministry of Health on their appointment as field promoters. They agreed to professional secret keeping during data collection and interpretation process. They are working at the clinic and are aware of the professional secret keeping code.

The unique identifiers were linked to names of the patients and contacts on a separate data form, but it was kept safe, separately by the researcher. The linkage is important for follow up of clinical evaluation and for outstanding results. The identifiable information was then destroyed after the data analysis process. Data were entered in Epi Info 7 with password protection to ensure that no unauthorized persons could access the information. The researcher was responsible for data analysis because of logistical constrains; she could not hire an assistant. Paper-based data was kept in sealed envelopes until data entry.

3.10 Summary

This chapter discussed the research methodology that was used in the study. The quantitative research methodology was discussed and its applicability for this study was explored and explained. The relevant aspects, pertaining to research design such as the data collection process, including sampling of the target population, data analysis and ethical considerations were explored in detail, to make the research methodology overt and detailed. The specific measures such as measures of association; significance testing used for quantitative research was explained. The next chapter presents the findings of the practical research.

CHAPTER 4.DATA ANALYSIS AND PRESENTATION OF RESULTS

4.1 Introduction

The previous chapter described the methodology, including research design, population, sampling and data collection. The current chapter presents the results of the analysis. The analysis was aimed at obtaining information which would provide answers to the following research objectives:

1. Determine incidence of TB disease among close and community contacts of TB patients. Descriptive statistics were used to describe characteristics of index cases. The characteristics studied were age, sex, type of TB, HIV status, and case fatality. Tuberculosis disease in close and community conducts was described too.

2. Compare risk of TB disease among close and community contacts of TB patients. Analytical statistics were used and the relative risk was calculated to determine the risk of disease in close contacts compared to the risk in community contacts.

3. Determine the risk factors for TB infection and disease among households with confirmed TB patients and households without TB patients. Data was analyzed by calculating the risk ratio with corresponding 95% Confidence intervals. The analysis was stratified for the following risk factors: close versus community contact, age, sex, and household density.

4. Compare the prevalence of infection among study participants from households with confirmed TB patients and study participants from household without TB patients. The prevalence of infection in the close and community contacts was calculated. Prevalence was tabulated and compared and relative risk of infection among close and community contacts were calculated to determine the association.

4.1.1. Objective 1 Determine incidence of TB disease among close and community contacts of TB patients

4.1.1.1 Tuberculosis index cases

For the calendar year of 2014, 56 index TB patients were registered. Fourteen patients (25%) from all registered patients were DR-TB patients. Of all registered TB patients 50% (n=28) were females and the remaining half were males.

The males were more, than females among the 0-15 age group and males the majority among the 31-45 age group. The age and sex distribution of the index cases can be seen in figure 4.1.

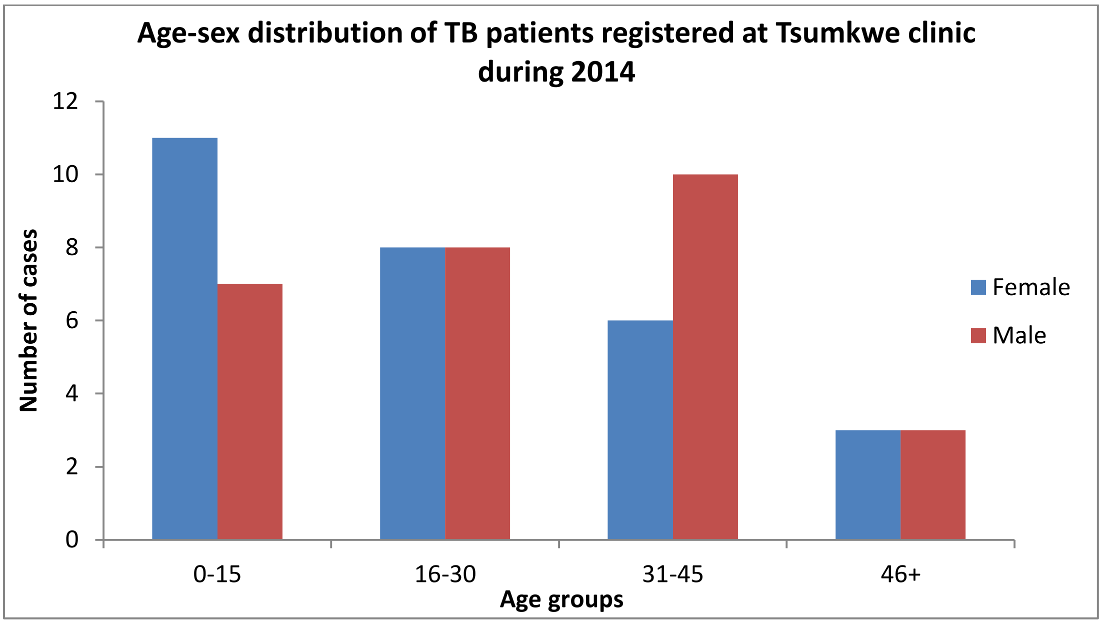


Figure 4.1 Age-sex distribution of index cases

Additionally to age and sex, all index cases registered for TB treatment were tested for HIV. Only one (2%) out of the 56 index cases was positive for HIV.

Fatality rate:

Three index cases died while on treatment, that amounts to 5% case fatality rate. One was a 14 year old female who died one month after commencement of treatment and the other a 7 year old male who died four months after initiation of treatment. A 25 years old male, who was diagnosed with XDR-TB after failing on susceptible TB treatment, was the third reported death.

4.1.2 Incidence of TB disease among close and community contacts of TB patients.

Close contacts

The total number of close contacts was 66 and they were exposed to 34 index cases in a confined environment. All the close contacts examined had shared a hut with the index case for more than 30 days before the initiation of TB treatment. Out of the 66 close contacts, 8 (12%) were diagnosed with active TB and were therefore regarded as secondary cases of the index cases. All of them were diagnosed within 12 months after the exposure to the index case.

Community contacts

Pertaining to the community contacts; 102 community contacts were selected and they were sharing a homestead with the 34 index cases. Out of all the 102 community contacts, 8(8%) were diagnosed positive for TB disease. One of them was diagnosed with DR-TB.

Drug-resistant TB patients

The total number of registered drug-resistant TB patients for 2014 were 14 people and contacts of 8 DR-TB index cases were examined. Of the 8 DR-TB index cases, seven index cases had in total 16 close contacts, and one had no close contact. Only one (6%) close contact (child of 1 year old) of the 16 close contacts was diagnosed with drug-resistant TB. The hut of the DR-TB patient without close contacts can be seen in the picture below (figure 4. 2.)

Figure 4.2. Hut of a drug resistant TB patient (hut without walls).

The total number of 33(32%) community contacts, of the 8 index DR-TB patients, was examined. Two (6%) out of 33 were diagnosed with MDR-TB, and both were adults. Both community contacts with disease were male (figure 4.3).

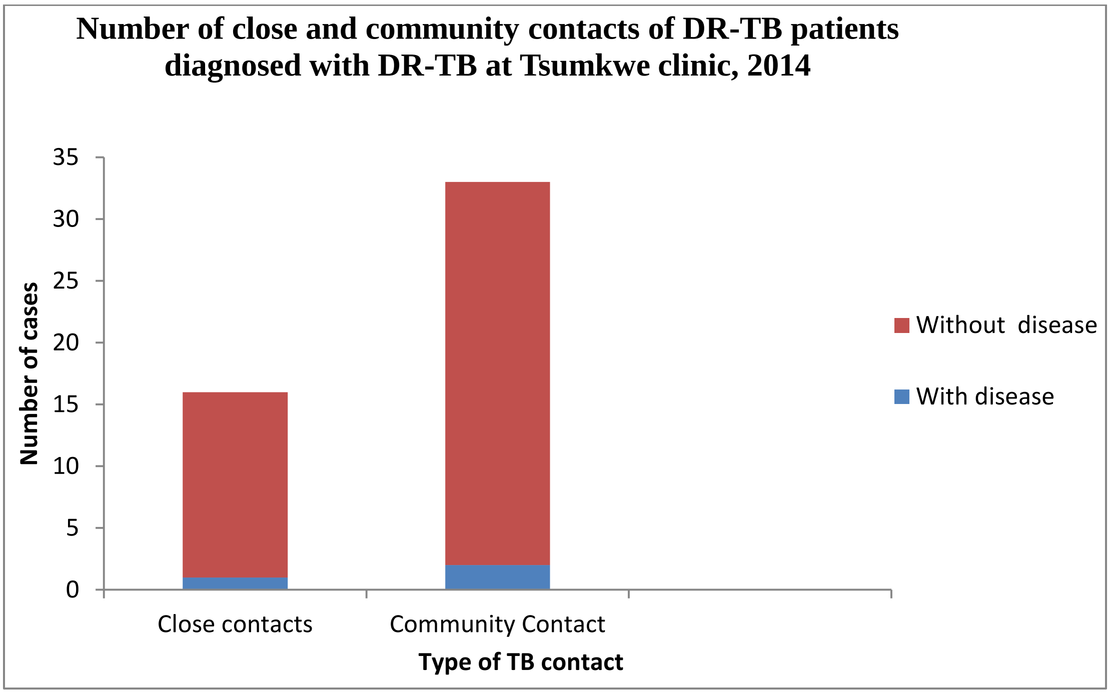


Figure 4.3: Number of contacts diagnosed with DR-TB disease.

4.1.2.1 Incidence of disease among children who were close and community contacts:

Close contacts

From the 66 close contacts 23(35%) were children 15 years and younger, and 6(26%) out of the total 23 child contacts were diagnosed with active TB. One (n=6) of them was diagnosed with drug-resistant TB. None of the child contacts were previously tested for infection or put on preventive therapy. The age of the children (close contacts) diagnosed with TB ranged between 1-9 years.

Community contacts

There were 24(24%) children among 102 community contacts. Four (17%) of the 24 child community contacts were diagnosed with TB disease. The ages of the child community contacts diagnosed with TB were between 6 and 12 years.

The percentage of close contacts with disease was more than the community contacts with disease. See figure 4.4 for children (≤15 year old) with TB disease:

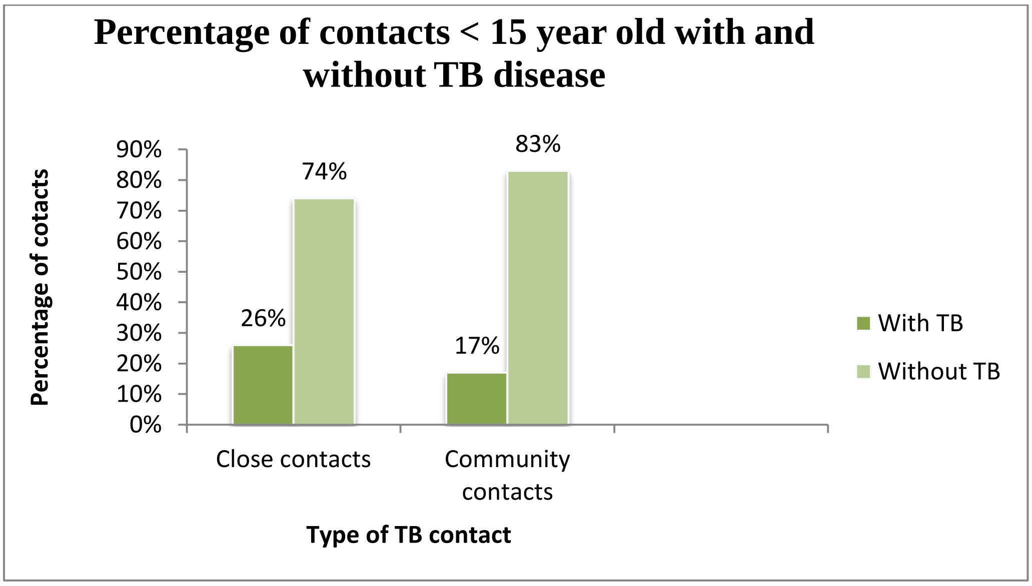


Figure 4.4 Percentage of contacts ≤15 years old diagnosed with TB

4.2 Objective 2: Compare risk of TB disease among close and community contacts of TB patients.

Relative risk was measured and the risk for the close contact to acquire disease was compared to the risk for community contacts. The crude relative risk was 1.5 (95% Confidence Interval 0.812 – 2.10). Age was adjusted for and the adjusted relative risk was 1.5(95% Confidence interval 0.50 – 4.83).The risk of close contacts of DR-TB patients to acquire disease was compared with the community contacts of DR-TB patients. The crude relative risk was 1.2. (Contingency table 4.1)

Table 4.1: Comparison of close and community contacts with and without DR-TB disease:

	Positive for DR-TB Disease	Negative for DR-TB Disease	Total
Household contacts (exposed)	1	15	16
Community contacts (unexposed)	2	31	33
Total	3	46	49

Crude relative risk: 1.2 (95% Confidence Interval: 0.1-10)

4.3. Objective 3: Determine the risk factors for TB infection and disease among households with confirmed TB patients and households without TB patients.

4.3.1 Household density in the homesteads:

The close and community contacts visited were from the following 8 villages of Tsumkwe constituency: Tsumkwe, //Xa/oba, Kaptein post, Duinepos, Ben se kamp, //Auru, #Nama pan, and Mountainpos. Tsumkwe settlement had the highest number of close and community contacts (Table 4.2).

Table 4.2 Number of homesteads visited and number of contacts per villages visited

Villages visited	Frequency (N = 23)	Number of contacts	
		Close contacts (%) n = 66	Community contacts n = 102
Tsumkwe	9 (39%)	27 (41%)	38 (38%)
//Xa/oba	1 (4%)	3 (5%)	5 (5%)
Kapteinpos	2 (8%)	2 (3%)	8 (8%)
Duinpos	3 (17%)	9 (14%)	13 (12%)
Mountain pos	2 (8%)	8 (12%)	13 (12%)
Ben se Kamp	4 (16%)	8 (12%)	14 (14%)
//Auru	1 (4%)	5 (7%)	5 (5%)
#Namapan	1 (4%)	4 (6%)	6 (6%)

The close contacts were sharing a one-room hut with the index case and 4-6 people were living together in a hut. The hut was used for sleeping during the night, but during day time people were congregated around the hut doing handicraft or leisure around the hut. The number of selected community contacts ranged between 3-16 people for one homestead. The mean of household contacts were calculated for the household size and number of positive contacts per the mean number of contacts was tabulated. The density of homesteads and disease was not associated among close contacts but among community contacts an association was found (Table 4.3)

Table 4.3: Average number of positive contacts per homestead members

Members of homestead	Average number of close contacts	Average contact diagnosed with TB disease (%)	Average sampled Community contacts	Sampled Community contact diagnose with TB disease
0-5	3	1 (33%)	3	0 (0%)
6-10	10	2 (20%)	18	2 (11%)
11 +	13	2 (15%)	24	3 (13%)

4.3.2. Risk of being a close or community contact

The risk for disease between close and community contacts was measured and the relative risk was 1.5 (95% Confidence interval of 0.812 – 2.16). Age was adjusted for and adjusted relative risk was 1.5 (95% Confidence interval of 0.5 – 4. 83). Sex or homestead member size was stratified too and no association was found between these variables and acquiring disease. See below the table 4.4:

Table 4.4: Risk ratio for risk factors for TB disease among study participants from Tsumkwe community, Namibia, 2014

Risk factor	Risk ratio	95% Confidence Intervals
Household versus Community contact	1.5	0.812 – 2.16
Age ≤15 years versus > 15 years	1.5	0.5 – 4.83
Sex Female vs male	1.1	0.5 – 1.9
Homestead density < 10 versus >10	1.01	0.4 – 1.6

4.4 Objective 4: Compare the prevalence of infection among study participants from households with confirmed TB patient and those from household without TB patient.

4.4.1 Prevalence of infection among close and community contacts

Close contacts

Tuberculin skin test was done on 32(48%) out of 66 close contacts. From the 32 close contacts, which were tested for infection, 12 (38%) close contacts had shown positivity on the TST. Five (42%) out of the 12 close contacts who were positive for infection were between 0 - 15 years old and the remaining 58% were adults. Seventeen (31%) out of the 54 community contacts reacted positive to the skin test. From the 17 community contacts who tested positive for infection six (35%) were under the age of 15 years and 11(65%) were adults.

Twenty (63%) out of 32 close contacts, who were subjected to the TST, was in the age group of 0-15 years. From the total close contacts (n=20) in the 0-15 age group tested for infection 5(25%) were positive for the skin test. The ages of close contacts tested positive for TB infection were in the range of 2-7 years.

Community contacts

A total of 54 out of the 102 community contacts were tested for infection. Among the community contacts 16(30%) out of the 54 community contacts tested were in the age group 0-15 years. Six (38%) out of 16 child community contacts tested, showed positivity to the skin test. The age of the child community contacts tested positive for infection ranged between 8-10 years. See figure 4.5 and figure 4.6 for the difference in percentage for all contacts compare to those 15 years and younger.

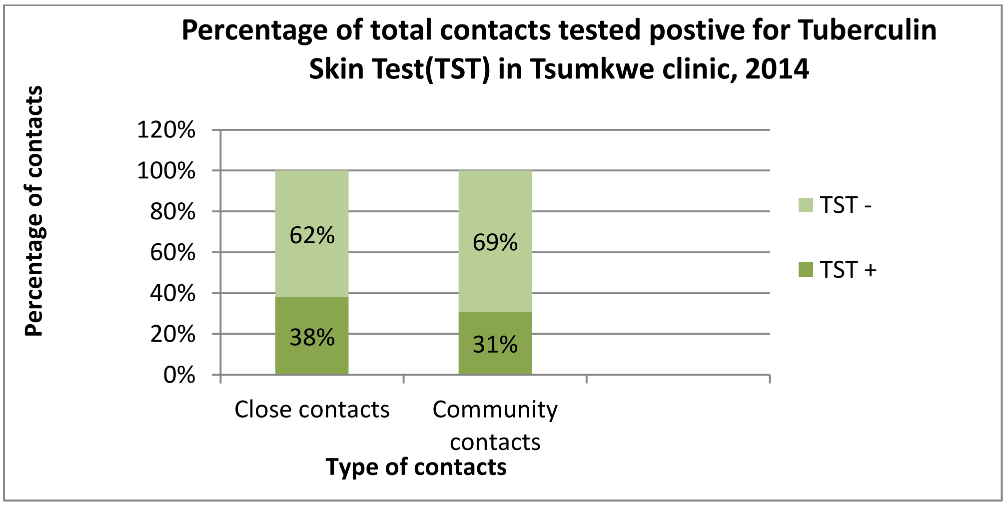


Figure 4.5 Percentage of all contacts tested positive for latent TB infection

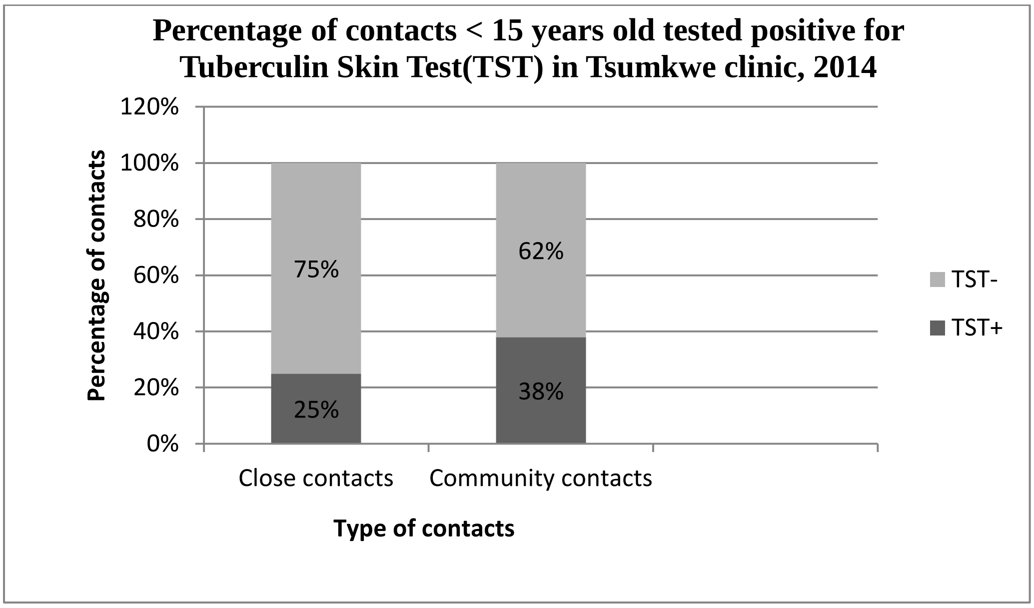


Figure 4.6 Percentage of children who tested positive for latent TB infection

Close contacts with positive reaction to the tuberculin skin test was compare to community contacts. The prevalence of infection among close and community contacts can be seen in the table below:

Table 4.5 Prevalence of infection among close and community contacts

	Prevalence of infection	
	Close contacts	Community contacts
Adults +children	38%	31%
Children (≤15 years)	25%	38%

4.5 Summary

The results chapter was informed by the data collected during the study period. The findings were explained with reference to the characteristics of the study participants, incidence of disease among close and community contacts of TB index cases registered during 2014.The incidence of TB disease among close and community contacts was compared to determine any association with the risk of disease. The prevalence of infection was computed and the risk ratio was calculated to determine the difference in infection between close and community contacts. The possible risk factors age, sex and density of homesteads were adjusted for.

The three important findings of this study was that incidence of TB infection and disease among contacts was associated with both close contact and community contacts. Secondly, age, sex and member size of homestead were not confounders for acquiring disease. It is however possible that if the sample size was larger the study could have more power. Thirdly, latent TB infection was higher among community contacts who were $\leq$15years than among close contacts $\leq$15 years. The Chi square test done to determine the statistical significance however the p-value was close to the margin, therefore the results were not statistically significant.

CHAPTER 5.DISCUSSIONS:

5.1. Introduction

This chapter provides the conclusions drawn from the results presented in the previous chapter. The findings will be discussed making inferences to the objectives of the study. The outcomes of the study will also be related to the literature reviewed. The findings attempt to provide information on the risk of close and community contacts developing disease after been exposed to a TB patient. It will additionally present the prevalence of infection among the close and community contacts of TB patients. The findings will be discussed under the following themes which are related to the objectives: 1) Incidence of TB disease among close contacts of TB patients compared to the community contacts, 2) risk factors for disease among close and community contacts, 3) prevalence of infection among close contacts compared to the community contacts. Additional to disease and infection among contacts of TB patients, the study also looked into case fatality among index cases. This discussion is presented according to the study objectives as detailed below.

5.2 Objectives 1 and 2

The first objective of this study was to determine the incidence of disease among close and community contacts of index TB cases; the second objective was to compare the risk of disease between the two groups. These two objectives will be answered together in the following paragraphs.

5.2.1 Incidence of TB disease among close contacts compared to community contacts

All the close contacts, included in this study, were exposed to a TB patient in a confined environment for more than 30 days before the initiation of TB treatment of the index case. The close contacts were living in the same hut with the index cases and community contacts were staying in the same homestead with the index cases and were sharing fireplaces and other social gathering places. The percentage of close contacts that developed disease was more than the community contacts that developed the disease. However, the result was not statistically significant therefore it is not possible to say there is a difference in incidence of TB between the two groups. The findings of the current study are in contrast with a study done in South Africa (Shapiro et al 2005) that concluded that TB incidence among close contacts is ten times more than community contacts. However findings of other studies suggested that TB transmission in the community can be higher than in the household (Kompala et al., 2013, Cohen et al. 2012, Buu et al. 2010)The contrast observed between previous studies and the current one could be the difference in socio-economic status of the study population or the difference in disease burden. Given the uniqueness of the study population and the results obtained, this study will suggest that close and community contacts have equal risk of developing disease when exposed to a TB patient. In relation to the latter, both close and community contacts should be regarded as high risk group for prevention and control strategies.

In the event that both close and community contacts are risk groups, early identification, diagnosis and treatment of suspected TB patients as well as their contacts, in order to decrease transmission of TB, is a cost-effective method to prevent the propagation of the spread of the disease.

5.2.2 Disease among children who were close and community contacts:

When data analysis was stratified into age groups, the proportion of close contacts that develop disease were more than the proportion of community contacts that develop disease. The calculated adjusted relative risk did not indicate a statistically significant difference between the two groups. The findings of a study by Marais and colleagues (2009) concluded that young children can be infected inside as well as outside of the household. In light of the latter, the progression to disease for young children is inevitable especially in the event of re-infection (Marais, Hesseling & Schaaf, 2009). A study by Middelkoop and others confirmed that younger children have multiple sources of infection and consequent disease; therefore this current study will conclude that close and community contacts who are children have an equal risk for re-infection that results in progression to disease. If the results of the current study are true, then age is not confounding the risk of disease progression between close and community contacts.

Considering the latter, interruption of transmission from adults to vulnerable children should be a priority in any high incidence setting. The lack of significant difference between close and community contacts underscores the need to target the ≤15 year old age group for preventive activities, if they are living in the same homestead with an index case in this specific community.

5.2.3. Incidence of DR-TB among close and community contacts

One close (6%) and two community contacts (6%) of DR-TB patients were found to be diagnosed with the DR-TB strain. The percentage of participants diagnosed with DR-TB was the same among close contacts and community contacts; however the number of DR-TB patients was few, and could not give the study sufficient power. These results slightly co-incite with the results of a study by Lueng and Kam (2013) that suggested that while household could be at risk of transmission of the resistant strain of TB, community members outside of household could also be at risk. The transmission risk is due to the long infectivity of drug-resistant TB.

A study by Vella and colleagues (2011) indicated a high number of close contacts with DR-TB compare to community contacts. However, another study by Cohen revealed that community contacts of DR-TB had higher number of DR-TB. Given these inconsistent findings, this present study abides by its results that close and community contacts have the same incidence of DR-TB disease.

5.2.4 Incidence of DR-TB among children

A one-year old child, who was a close contact, was infected with a resistant strain. The child was 3 months at the time the mother was initiated on DR-TB treatment and was not isolated from the mother. Therefore the likelihood of vertical transmission of DR-TB to this child is possible. Becerra, Appleton and Franke (2013) proof, with their research results that children in households with resistant TB have 30 times more risk than the general population. In line with the latter, the national guidelines for the management of TB stipulate that “mothers with DR-TB treatment should avoid contact with infants till smear and culture is negative.” The guidelines further stipulated that “safe feeding practices should be instituted” (MOHSS, National Guidelines for the Management of TB 2012). It was found in the community under study that infants where not isolated from their parents when positive for TB, therefore adherence to national guidelines needs to be strengthened.

A study by Pillay and Sturm showed that vertical transmission of Mycobacterium TB (VTRTB) from mother to child was 6% among new-borns of mothers with maternal TB disease. The same study concluded that the risk of mother-to-child transmission from an untreated or partially treated mother is 15-16% (Pillay, Sturm, Khan & Adhikar, 2004). Therefore, timely diagnosis and treatment of DR-TB patients, isolation of infectious patients, and the prevention of vertical transmission of DR-TB should be addressed through specific interventions, and adherence to guidelines should be encouraged, in Tsumkwe constituency.

5.3 Objective 3

The third objective was to determine the risk factors for infection and disease among close and community contacts of index TB cases.

5.3.1 The risk factors for disease among close and community contacts

We found in our study that close contacts with disease were equally distributed between males and females. The distribution was similar among community contacts as well but more males than females had DR-TB. This study therefore suggests that gender is not a risk factor for acquiring infection and consequent disease among close contacts. However incidence of DR-TB was prevalent among males. The finding of our study is in contrast with the national statistics, which indicates that more males with TB disease are admitted in hospitals for treatment of susceptible TB (MOHSS, NTLP Annual Report 2014-2015) compare to females. However the incidence of DR-TB among males, who were community contacts, could be an indication of undetected spread of resistant strain of TB among males in the community.

As this study did not do any genotypic linking of cases, it is not clear as to whether these men could have got the infection from sources other than their contacts. The results of the study by Cook and others (2007) underscore the association between mobility and TB infection. It can therefore be accepted that men frequently visit congregate settings and, therefore, might acquire infection outside and inside the household. Therefore in-depth investigation to determine social networks of the mobile groups, such as men, could shed light on this unknown area.

Young age could be a possible risk factor for progressing to disease. More children that were close contacts were diagnosed with TB disease compare to the close contacts that were older than 15 years. This finding suggests association between been younger than 15 years and acquiring TB disease.

Additionally, congregated settings were hypothesised as possible risk factors for infection and consequent disease. Homesteads with many inhabitants might be seen as overcrowded settings. The arrangement of a homestead can be seen below.

Figure 5. Typical homesteads in Tsumkwe constituency

In relation to overcrowded settings, the findings of previous studies indicated that high numbers of social networks are enhancing TB transmission. Wood and others(2010) cited in their study that people with more social networks have a greater risk of acquiring infection and disease inside and outside the household (Wood, et al., 2010). Murray and her colleagues have reinforced this notion by recording findings that found an association between overcrowding and broad social networks with TB infection (Murray et al., 2009). In light of this, high homestead size is an apparent risk factor for transmission. The results of this study, however, did not indicate an association between homestead that had a high number of members and increased number of individuals with TB disease. These results, however, should be interpreted with caution because the huts used as the comparison group could not be representative of the entire homestead.

5.4. Objective 4

The fourth objective of this study was to compare the prevalence of infection among close and community contacts of index TB cases.

5.4.1 Prevalence of latent TB infection among close and community contacts:

Tuberculin Skin test was used in this study to determine the prevalence of infection among the asymptomatic close and community contacts of the TB patients. The skin test is often used together with physical screening and chest x-rays to confirm TB disease especially in children. For this study TST was regarded as a predictor of the prevalence of TB infection. The skin test was regarded as positive if the induration diameter was $\geq$ 10 mm.

Thus, more than a third (38%), of the close contacts who were tested reacted positive to the skin test. This finding indicated a lower percentage compared to a study by Sia (2010) which reported 65% of positivity of TST among close contacts. The observed difference could probably be attributed to differences in the burden of disease. Adults were the majority among those who reacted positive to the skin test; this could be explained by the fact that adults have a longer lifespan to acquire infection. Latent infection among adults might not be seen as a serious risk. However, although an asymptomatic person cannot spread the infection, the concern is that it is not known when the person will start to develop symptoms. It is therefore imperative that health education be given and available interventions be implemented to stem the progression to disease. The knowledge of signs and symptoms should be emphasized among community members to enhance awareness, to seek help promptly.

A substantial number, 31% of the community contacts tested for TB infection showed a positive reaction. The number of community contacts with latent infection was fewer than close contacts, but the difference was not statistically significant. It is possible, therefore, that the results of this study reflects that both close and community contacts could have the same proportion of individuals with latent infection. The latter is likely given the fact that infection can be acquired over time and even outside of the household.

Murray and Marais (2009) found high number of cases with TB in dense areas outside of households with TB. The latter results agree with what we found that close and community contacts share an equal risk of infection. Additionally more evidence is available that TB transmission is prevailing in the community outside the confinements of the household. Cook and others (2007) in their study highlighted the findings that TST positivity was strongly associated with visiting dense social aggregated places. These social aggregations could be reservoirs of infection. It is therefore possible, as other studies have disclosed that undetected infected contacts are out there in the community, and are responsible for the ongoing spread of TB. Hence, there is a need for a community approach to prevention and care activities.

5.4.2 Latent TB infection among children who were close and community contacts

When stratification was done, it was found in the current study that a child who is a close contact could have less risk of infection compared to the community contacts who were children. It appears as if age is an effect modifier. This effect could be attributed to the fact that close contacts are younger children compare to community contacts who are older children. It can be assume that older children have a longer period of exposure and consequent infection.

The high prevalence of infection among the child community contacts that was found in the current study could be attributed to the risk of re-infection that exists for children living with index cases with TB. The risks of infection for community contacts are often underestimated if they are not in a close, confined environment with TB patients. However, results of some studies demonstrated that community contacts contributed significantly to the case load of TB (Radhakrisna, et al, 2007). Therefore, although the strength of exposure might not be perceived as high for community contacts, evidence at hand is compelling, to regard both close and community contacts as risk groups.

In comparison, a study by Fairly, Beylis and Reubenson (2011) found the prevalence of TB infection among close contacts who are children to be lower than 10%, which is a third of the prevalence found for the present study. The high prevalence found in the present study is however consistent with the prevalence found in another study of Nguyen and Odermatt that recorded prevalence of latent infection among general TB patients at 31% (Nguyen, Odermatt & Slesak, 2009). The fact that prevalence of latent TB infection among children in this community is the same as among the general TB patients could mean that children area high risk group for TB.

It is, therefore desirable that child contacts be screened for active disease and if negative, put on Isoniazid Preventive Therapy (IPT) unless they are contacts of MDR-TB patients. It however, came to light that the child contacts of TB patients were not initiated on IPT. The health workers hinted that the initiation of IPT is subtly not talked about, because of the high prevalence of MDR-TB in this community. However the National Guidelines for the Management of TB outlines that " all children <5 years old who have had contact with sputum-positive TB patients, including infants born to mothers with infectious TB disease, should have supervised isoniazid prevention therapy once active TB disease has been excluded". It is important that the guidance provided by the national guidelines be followed.

While the observations in our study indicated the vulnerability of both close and community contacts to infection and disease, awareness of signs and symptoms among contacts could enhance prompt help seeking behaviour among contacts. Preventive therapy could be proposed in advance for contacts with infection and special support and care measures could be sought for contacts of patients with the resistant strain of Mycobacterium Tuberculosis.

Furthermore the awareness among health workers of the infection status of contacts, especially children, should facilitate prompt diagnosis and care. In the worst case scenario, people with infection and consequent disease may reach health facility at a time when their prognosis is very low. Therefore rapid testing options including tuberculin skin test can help health workers to be alert of the prevailing infection.

CHAPTER 6. SUMMARY, LIMITATIONS AND RECOMMENDATIONS

6.1 Introduction

The study investigated the incidence of TB disease among close contacts of TB patients in comparison to community contacts. Additionally the prevalence of infection among close and community contacts was measured. The focus of the study was on close and community contacts of index cases, but the characteristics of index cases were described too.

6.2 Summary

In spite of mentioned limitations, this study has made contributions to the literature on TB incidence and transmission in Namibia. The number of close contacts of TB patients who developed TB disease was more than the community contacts but the risk was not statistically significant. It can therefore be concluded that the risk is the same for both close and community contacts to progress to active disease, once infected. The number of close contacts that were children and developed the disease were however more than the community contacts the difference, though was not statistically significant. In response to the first objective and second objective no difference of risk could be found between close and community contacts to progress to disease once infected

The third objective was to determine the risk factors for acquiring TB disease. The following variables sex, age and homestead density was examined for been risk factors for TB disease. Homestead density was found as a risk factor for community contacts to develop TB disease. Although sex and age was not established as risk factors the results could be confirmed with a sample with stronger power.

The fourth objective of this study was to compare the prevalence of infection between close and community contacts. The results revealed that more children who were community contacts had LTBI compared to children who were close contacts of TB patients. This finding signals a high burden of undiagnosed TB infection among children in the community. All contacts, regardless of whether they are close or community contacts, should therefore be considered for public health actions.

Additionally, in response to the fourth objective; close and community contacts of DR-TB patients showed a significant reaction to the TST. This could mean that contacts of DR-TB index cases have an increased risk of infection. Contacts of DR-TB patients should therefore be subjected to close monitoring and available TB control interventions should be applied.

6.3. Limitation of the study

Matching of strain types of *Mycobacterium tuberculosis* for the contacts and their index cases was beyond the scope of this project. It will therefore not be possible to confirm likely source case through genotypic linking. Moreover the results of the study cannot be generalized to all districts and regions, because the people of Tsumkwe constituency and their living arrangements are not representative of the general population in Namibia.

The process of obtaining direct smear microscopy results from the laboratory was tedious due to the fact that the closest laboratory service was 300-500km away from Tsumkwe clinic. It took 6 weeks to 2 months to get the results. No X-ray facilities were available on the premises, and X-rays are only provided on doctors' request. Therefore, X-ray examination could not be done for contacts that were suspected of disease.

Furthermore the researcher could not countercheck the available data on HIV status from the facility registers with patients because of confidentiality issues. Additionally, HIV testing was not within the scope of this study. The Tuberculin Purified Protein Derivative (PPD) for the TST was not available at the medical stores and caused delays in doing the TST.

The review done by Suzman in Namibia on the social situation of the San people was outdated but was used because it was a sociological review. While the limitations mentioned here could have a bearing on the usefulness of the study, the study can provide important information that can form the baseline for future studies.

6.4. RECOMMENDATIONS

The study identified shortcomings in the care and treatment of close and community contacts of TB patients. Based on the findings the following recommendations were made.

6.4.1 Recommendations for practice:

National TB and Leprosy program:

It is therefore recommended that Geographic Information Systems been used to identify clusters of cases in villages and geographic mapping of villages, with clusters of TB cases, been made for proper monitoring of contacts.

District Health Management:

Grootfontein district management should urge health workers to implement existing guidelines with regard to IPT to reduce progression from infection to disease among infected child contacts.

Health workers at clinic level:

Health workers at Tsumkwe clinic should endeavour to ensure early identification, diagnosis and treatment of secondary cases. Health workers should provide health education and nutrition support for nursing mothers with TB disease to prevent vertical transmission of TB.Health workers at Tsumkwe clinic should improve on case detection and available diagnostic techniques should be used to diagnose TB in children in remote places.

Awareness of signs and symptoms of TB among community members should be enhanced by health workers and field promoters to promote early diagnosis. More field promoters who are fluent in the local language should be employed to improve on health education and promote better interaction with the community.

The findings of this study support the improvement of infection control practices in the community. Intensified case finding and monitoring of DR-TB patients' contacts should be improved for prevention and prompt diagnosis of DR-TB.

6.4.2 Recommendations for future research

While technology is advancing, non-invasive rapid tests for children with TB should be explored. The National TB and Leprosy program should embark upon molecular genotypic testing to link index and secondary cases better.

Since patients are hospitalized for long periods, it is recommended that future studies be done by national TB program to determine the extent of nosocomial infection among hospitalized patients.

CHAPTER 7.REFERENCES

Andrew, J., Morrow,C., Walensky R.P.,& Wood R.(2014).Integrating Social Contact and Environmental Data in Evaluating Tuberculosis Transmission in a South African Township.*Journal of Infectious Diseases, Volume 210, pg. 597-603.*

Becerra, M., Appleton, S., Franke, M., Chalco, K., Atreaga, F., &Bavona, J.(2011). Tuberculosis burden in the households of patients with multi-drug and extensively drug resistant tuberculosis: A retrospective cohort study. *The Lancet, Volume 377, pg. 147-152.*

Buu T., Van Soolingen, D., Huygen, M. N. T., Nguyen, L.N.T., Hoang, T.Q Tiemersma, E., W., Borgdorff, M., W., &Cobelens, F.G.J. (2010).TB acquired outside of the household – Rural Vietnam.*Emerging Infectious Diseases Journal, Volume 16, pg. 1466-1468*.

Chauhan, L.S., Dara., M., Figueroa-Munoz, J., Hanson, C., &Martinez, L.(2005). Addressing poverty in TB control: Options for national TB control Programmes, *Geneva: World Health Organization*.

Chirwa, T., Floyd, S., Ponnnighouse, J., Malema, S., Kileta, S., Zaba, B., Bliss, L., & Fine, P.(2004).Household dynamics in northern Malawi during 1998.*Southern African Journal of Demography, Volume 9, pg. 1-23.*

Claasen, M., VanSchalkwyk, C., & Den Haan, L.(2013).High prevalence of Tuberculosis and insufficient case detection in Western Cape, South Africa.*Plos One, Volume 8.*

Cohen, T., Murray M.,Abubakur I., Zhang, Z., Sloutsky, A., Arteaga, F., Chalco, K., Franke, M., & Becerra, M.(2011). Multiple introductions of Multidrug TB into households, Lima,Peru,*Emerging Infectious diseases Journal Volume 17, pg.969-975*

Collins English dictionary (1996) Harper Collins Press, Glasglow

Cook, V., Sun, S.,Tapia, J., Muth, S., Arguello D., Lewis, B., Rothenberg, R., & McElroy, P.D.(2007). Transmission network analysis in tuberculosis contact investigations. *The Journal of infectious disease Volume 196, pg.1517 1527.*

Crampen, A., Glynn, J.R., Traore, H., Yates, M., Mwaungulu, L., Mwanubabu, M., Chaguluka, S., Floyd, S., Drobniewsky F., & Fine, P. (2006).Tuberculosis transmission attributable to close contacts and HIV status Malawi, *Emerging Infectious Disease Journal, Volume 12, pg.729-735.*

Devlin, S.,&Passmore E. (2013).Ongoing transmission of Tuberculosis in Aboriginal community in New South Wales.*NSW Public Health Bulletin, Volume 24, pg. 38-42.*

Diekmann, U., Thiem, M.,&Hays J.(2011).Scraping the Pots, San in Namibia,and two decades after independence, *Legal Assistance Centre, Documentary, Windhoek, Namibia.*

Dye, L., Williams, J., &Raviglione, M.(2009).Trends in tuberculosis incidence and their determinants in 134 countries.*Bulletin World Health Organization, Volume 87, pg. 683-691.*

Fairly, L., Beylis, N., & Reubenson, G. (2011).High prevalence of childhood MDR-TB in Johannesburg South Africa, *BMC Infectious Diseases Journal, Volume 11, pg. 28*

Figueroa-Munoz, J., & Ramon-Pardo, P. (2008), *Bulletin of the World Health Organization, Volume 86, 733-735.*

Henneken, C.H., Buring, J.F.,(1987) Epidemiology in Medicine, Philadelphia, Lippincott Williams & Wilkenson(reprint)

Honarvar, B.; Odoomi, N.,Rezaei A., Haghighi H.B., Karimi, M., Hoseini, A., Mazani, S., Panahi, M., Jamshidi, F., Moghadami, M., &Lankarani, K.B. (2014) Pulmonal Tuberculosis in migratory nomad populations: the missing link in Iran's

National Tuberculosis Programme.*The International Journal on Tuberculosis and Lung health, Volume 18, pg. 272-276.*

Jansen, J.P.,&Rieder, H.L.(2008).An ecological analysis of incidence of tuberculosis and *per capita* gross domestic product. *European Respiratory Journal, Volume 32, Issue 5.*

Jauch, H., Edwards, L.,& Cupido, B.(2010)*Booklet on Inequality in Namibia, Windhoek.* Availailable from: Labour Resource and Research Institute (LaRRI), www.larri.com.na.

Khalilzadeh, S., Masjedi, H., Hosseini, M., Safavi, A. &Masjedi, M. (2006).Transmission of Mycobacterium Tuberculosis to households of tuberculosis patients: a comprehensive contact tracing study. *Archives of Iranian medicine, Volume 9, pg. 208- 212.*

Kompala, T., Shenoi, S., &Friedland, G. (2013).Transmission of tuberculosis in resource-limited settings. *Current HIV/AIDS reports, Volume 1, pg. 264-272.*

Leung, E., Lueng, C., & Kam, K.(2013). Transmission of Multidrug resistant and Extensively Drug resistant TB. *European Respiratory Journal, Volume 41, pg. 901 – 908.*

Levin, S., 2007, UNDP Namibia. Trends in human development and human poverty in Namibia*: Background paper to the Namibia Human Development Report.* Available from: http://www.sarpn.org/document_report_Namibia.

Lonnroth K., Jaramillo E., &Williams B.,Dye, C., &Raviglione, M., (2009).Drivers of tuberculosis epidemics: the role of risk factors and social determinants. *Social Science and Medicine Journal Volume 68, pg.2240-2246.*

Malakmadzi N., Gonzalez, I. &Oemig I.(2005). Unsuspected recent transmission of Tuberculosis among high risk groups: implications of genotyping in its detection. *Clinical infectious disease journal Volume 40, pg.363-373.*

Maree, K., (2010). First Steps in Research. Pretoria: Van Schaik Press.

McGraw-Hill Dictionary of Scientific and Technical terms (2002) Princeton University Library, Princeton, New Jersey.

Middelkoop K., Bekker L., &Murrow C., Lee, N., Wood, R. (2014).Decreasing household contribution to TB transmission with age: retrospective geographic analysis of young people in South Africa Township. *BMC Journal Volume 14, pg. 221*

Ministry of Health and Social Services. National TB and Leprosy programme Annual Report 2011-2012, Windhoek, Namibia.

Ministry of Health and Social Services. National TB and Leprosy Programme Annual Report for the period 2012-2013, Windhoek, Namibia.

Ministry of Health and Social Services. National Tuberculosis Drug resistant TB survey 2008, Windhoek, Namibia.

Munch Z., Van Lill S. & Booysen C.(2003). Tuberculosis transmission in high incidence area: a spatial analysis. *The International Journal of Tuberculosis and Lung disease, Volume 7 pg.271-277.*

Murray, E., Marais, B., & Mans, G. (2009).A multidisciplinary method to map potential tuberculosis 'hot spots' transmission in high burden communities. *The International Journal of TB and Lung disease, Volume 13 pg. 767-774.*

Namibian News Network 2013. Editorial: Celebrating World TB day 2013, Windhoek, Namibia. Available from: www.namibiannews.com.na.

Namibian Population and Housing Census 2011.*Namibia Statistics Agency (NSA), Government of Republic of Namibia, Windhoek.*

Oxford New English dictionary (2002) Oxford University Press, Oxford University, Cambridge.

Oxlade O. & Murray M. (2012). Tuberculosis and Poverty: Why Are the Poor at Greater Risk in India? *Plos One, Volume 7.*

Pillay, T., Sturm A.W., Khan, M., &Adhikar, M.(2004).Vertical transfer of Mycobacterium Tuberculosis in Kwazulu Natal. *The International Journal of TB and Lung diseases, Volume 8, pg. 59-69.*

Radhakrishna S.,Frieden T., &Subramani R.(2007).Additional risk of developing TB for a household with a TB case at home at intake: a 15 year study. *The International Journal on Tuberculosis and Lung Health, Volume 11 pg.282-288.*

Ramos, J., Reyers, F., &Tesfamarian A. (2010). Childhood and Adult TB in a rural hospital in South East Ethiopia: a ten-year retrospective study. *BMC Public Health, Volume 10, pg. 215.*

Ricks, P., Mavhunga, F., & Modi, S.(2012). Characteristics of Multi drug resistant Tuberculosis in Namibia. *BMC infectious disease, Volume 12, page 358*.

Seung, K., Omatayo., D., &Keshavjee, S.(2009).Early outcomes of MDR-TB in high HIV prevalence setting in Southern Africa. *Plos One, volume 4*.

Sia J.G., Orillaza R.B. &Sauer J.L. (2010). Tuberculosis attributed to household contacts in the Philippines. *The International Journal on Tuberculosis and Lung Health, Volume 14, pg. 122 -125.*

Shapiro, A.E., Variava, E.,Radkohong, M.H., Moodley, M.,& Luke, B. (2012). Community based Targeted Case Finding for Tuberculosis and HIV in Households Contacts of Patients with Tuberculosis. *American Journal of Respiratory and Clinical Care Medicine: Volume 185, pg. 1110-1116.*

Streicher, E.,Mulller, B., &Chihota, V.(2012).Emergence and treatment of MDR-TB and XDR-TB in South Africa. *Journal for Infection, Genetics and Evolution, Volume 12, pg. 686-694.*

Suzman, J., Legal Assistant Centre (2001). An Assessment on the Status of the San in Namibia. Windhoek, Namibia.

Tessema B., Beer J., Merker M., EmmrichF.,Sack U., Rodloff A.,&Nieman S.(2013).Molecular epidemiology and transmission dynamics of Mycobacterium tuberculosis in Northwest Ethiopia. *BMC Infectious diseases, Volume 13, pg. 131-131.*

Uukunde, P., Mungunda, H., Ruswa, N., Mavhunga, F., Platt, G.,& Goenka, A. (2011). Management of Drug-resistant TB Among the San Community in Namibia: A Call for Community Engagement.*Unpublished project report, Windhoek, Namibia.*

Van Wyk S., Mandalakas A., &Enorson D.(2012). Tuberculosis contact investigation in a high-burden setting: House or household? *The International Journal on Tuberculosis and Lung Health, Volume 16*, pg. 157-162.

Vella, V., Recalbuto V., & Guerra, R. (2011).Household contact investigation of multidrug-resistant and extensively drug-resistant tuberculosis in a high HIV prevalence setting. *The International Journal on Tuberculosis and Lung Health, Volume 15, pg. 1170-1175.*

Verver, S., Warren, R., Munch, Z., Richardson M. & Van Der Spuy G.D., (2004). Proportion of transmission of Tuberculosis that take place in high incidence area. *The Lancet 2004, Volume 363, pg. 212-214*.

Webster Medical dictionary, (2000). National Library of Medicine, National Institute of Health, Bethesda

Whalen C., Zalwango S., &Chiunda A., Malone, M., Eisenach, K., Joloba, M., Boom, W.H., &Mugerwa, R.(2011).Secondary attack rate of Tuberculosis in Kampala, Uganda. *PLOS One, Volume 6.*

Wilmsen, E.,&Denbow, J.(1991). Almost outcast: Paradigmatic History of San-speaking people, Sociological analysis report, Windhoek.

Wood, R., Racow, K., Bekker, L., Morrow, C., Middelkoop, K., Mark, D.,& Lawn, S.D. (2012). Indoor networks in a South African township: Potential contribution of location to TB transmission. *PLOS One, Volume 7*.

World Bank 2013 www.tradingeconomics.co/namibia/population density.

World Health Organization.(2013). Global Tuberculosis (TB) Report 2013, Geneva, Switzerland.

World Health Organization.(2014). Global Tuberculosis (TB) Report 2014 Geneva, Switzerland.

World Health Organization. Fact sheet 2015, Geneva, Switzerland.

ANNEXURES

Annexure 1

FACILITY TUBERCULOSIS REGISTER:

TB 05: Facility Tuberculosis Treatment Register

Republic of Namibia
Ministry of Health and Social Services
National Tuberculosis and Leprosy Programme

Year--------------------

Date of Reg.	Reg. Number	Name (in full)	Sex M/F	Age	Address (in full)	Name of health facility where patient receives treatment	Date treatment started/ Regimen	P/ EP	Category of patient			
									New	Previously treated R/D/F	TI	O

N - New patient **R** – Relapse patient; sputum-smear positive, **F** = Treatment after Failure; **D** = Treatment –after-default, **TI** – Transfer In; patient referred from other treatment clinic; **O** – Other: please specify

TB 05: Facility Tuberculosis Treatment Register…. (Cont)

Sputum examinations (months)									Write date and month medicines were collected at 4 weekly period												HIV status	ART	CPT	CB-DOT option	No. of contacts traced	No. of contacts with TB	Date and c of Treat
Initial			2 months		5 months		7 months		1	2	3	4	5	6	7	8	9	10	11	12							
Sm	C	Xpert	Sm	C	Sm	C	Sm	C																			

Xpert – (+) **if M.tb is detected on Xpert MTB/RIF ; (-) if M.tb is not detected on Xpert MTB/RIF, or (ND) if Xpert MTB/RIF test is not performed. Cured** – sputum-smear negative **TC** – Treatmen completed (no smear) **Died** – patient died from any cause **Failure** – Sputum positive at 5 or 7 months, or changed to second line therapy before 5 months **Defaulter** – Interrupted treatment for 2 m
Transfer Out – Patient moved to another clinic, no outcome known **HIV** – Code 1 = pos; 2 = neg; 3 = unknown **CPT**- insert date of commencement, **ART**-insert date of commencement

Annexure 2

Structured Questionnaire for interviews

COMPARING THE RISK OF TUBERCULOSIS (TB) INFECTION IN THE HOUSEHOLDS WITH AND WITHOUT TB PATIENTS IN TSUMKWE CONSTITUENCY

QUESTIONARE:

PARTICIPANTS OF STUDY: CONTACTS ☐ **NON-CONTACT** ☐

Registration no. Index patient …………………………………(in case of contacts)

Date of interview……………………………..

1. **Demographic information:**

Unique ID:………………Sex………………………..DOB……………………Age………………

HIV status……………………Type of dwelling…………………………………Family size………………

Number of days lived with index case……………..

2. **Health History:**

Signs and symptoms: (Current)…….. * (In the past)……….

Coughing for more than two weeks (yes)…………(no)………… Night sweat (yes)………. (no)………. Fever (yes)………… (no)……… Loss of appetite (yes)……….. (no)……….

Weight loss (yes)………… (no)………

*If past signs and symptoms, indicate action taken……..

3. **Results:**

Direct microscopy results (positive)…………………..(negative)…………………………

Tuberculin skin test results (positive)…………………(negative)…………………………

Chest X-ray results…………………….. Date referred for treatment……………………

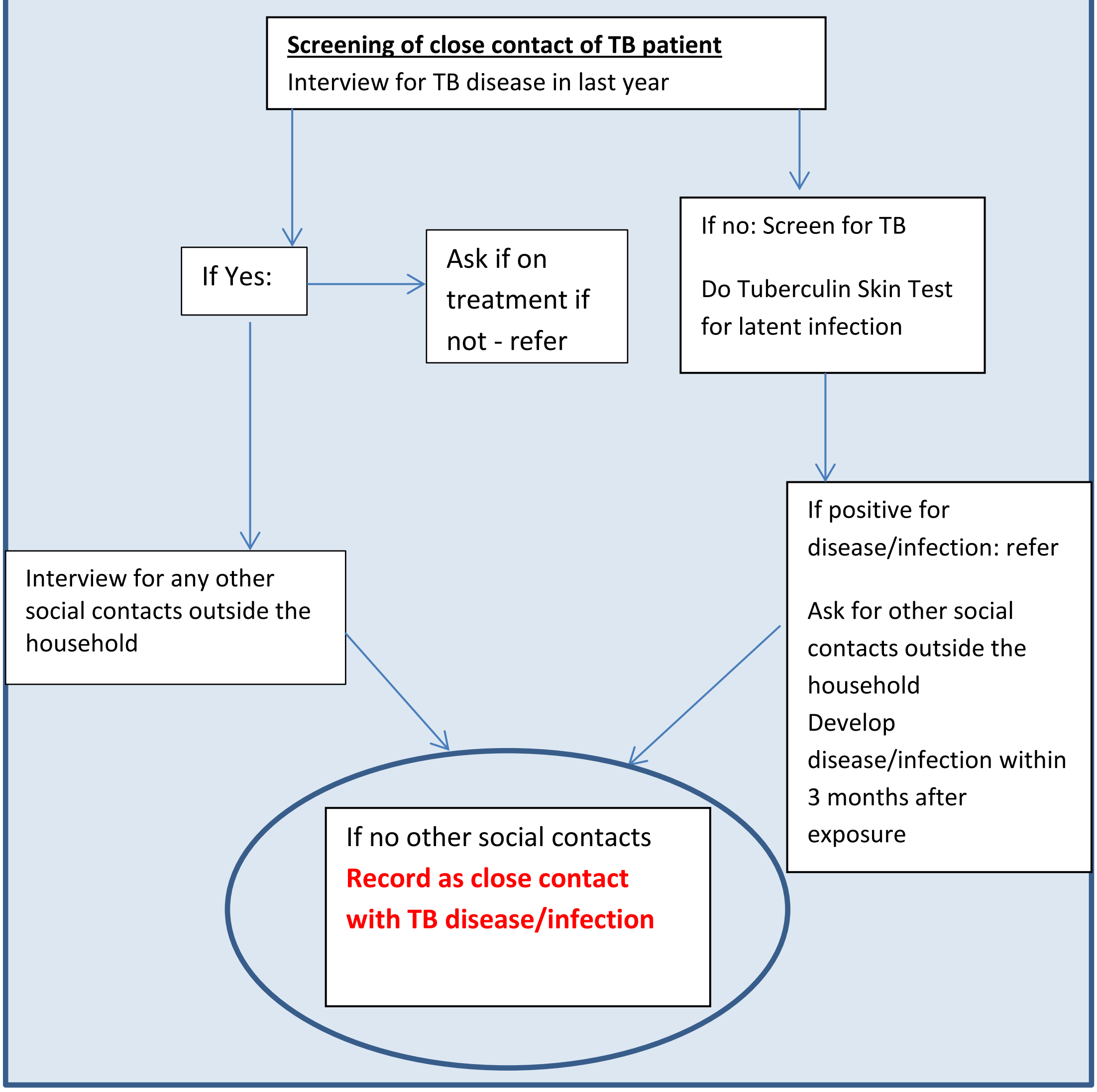
Consent:

Consent signed (yes)………………………...(No)……………………………………………………

Consent for minors (yes)…………………..(no)..

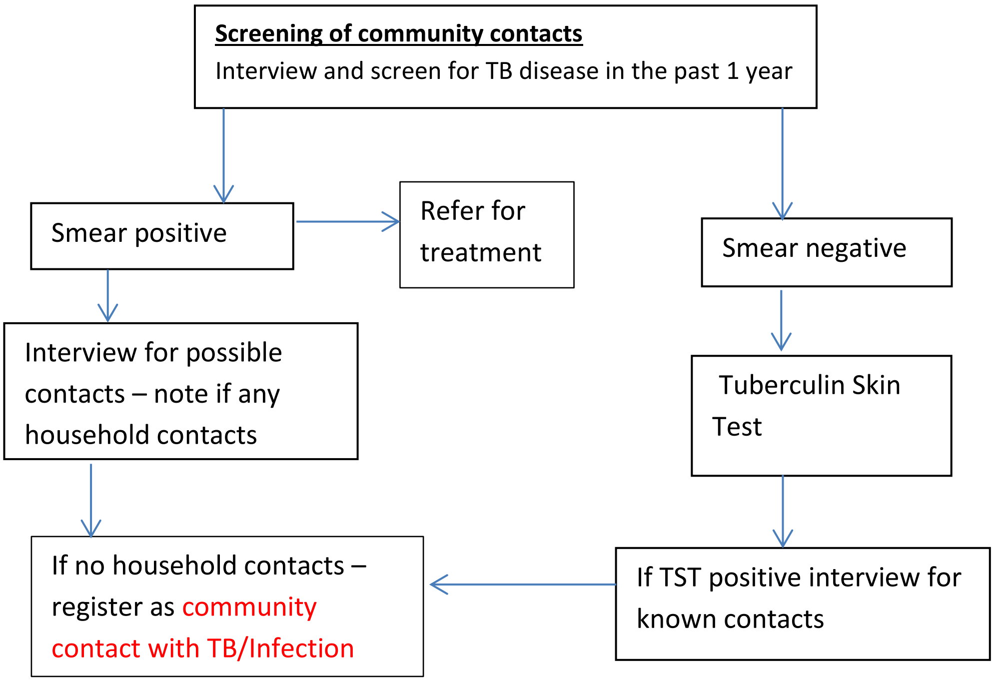
Annexure 3a

Algorithm for the screening of close contacts:



Annexure 3b

Algorithm for screening of community contacts:



UNAM
UNIVERSITY OF NAMIBIA

ETHICAL CLEARANCE CERTIFICATE

Ethical Clearance Reference Number: SONPH/5/2015 **Date: 10 February, 2015**

This Ethical Clearance Certificate is issued by the University of Namibia Research Ethics Committee (UREC) in accordance with the University of Namibia's Research Ethics Policy and Guidelines. Ethical approval is given in respect of undertakings contained in the Research Project outlined below. This Certificate is issued on the recommendations of the ethical evaluation done by the Faculty/Centre/Campus Research & Publications Committee sitting with the Postgraduate Studies Committee.

Title of Project: Comparing the risk of TB infection in the households with and without tuberculosis in Tsumeb Constituency Namibia

Nature/Level of Project: Masters

Researcher: ALBERTINA THOMAS

Student Number : 8204837

Host Department & Faculty: School of Nursing and Public Health

Supervisor : Dr K Hofnie ; (Main) (Co) Dr P Angula

Take note of the following:
(a) Any significant changes in the conditions or undertakings outlined in the approved Proposal must be communicated to the UREC. An application to make amendments may be necessary.
(b) Any breaches of ethical undertakings or practices that have an impact on ethical conduct of the research must be reported to the UREC.
(c) The Principal Researcher must report issues of ethical compliance to the UREC (through the Chairperson of the Faculty/Centre/Campus Research & Publications Committee) at the end of the Project or as may be requested by UREC.
(d) The UREC retains the right to:
  (i). withdraw or amend this Ethical Clearance if any unethical practices (as outlined in the Research Ethics Policy) have been detected or suspected,
  (ii). request for an ethical compliance report at any point during the course of the research.

UREC wishes you the best in your research.

Prof. I. Mapaure
UNAM Research Coordinator
ON BEHALF OF UREC

REPUBLIC OF NAMIBIA

Ministry of Health and Social Services

Private Bag 13198
Windhoek
Namibia

Ministerial Building
Harvey Street
Windhoek

Tel: 061 – 203 2125
Fax: 061 – 222558
E-mail: msimasiku@mhss.gov.na

OFFICE OF THE PERMANENT SECRETARY

Ref: 17/3/3
Enquiries: Mr. M. Simasiku

Date: 19th August 2015

Ms. Albertina Martha Thomas
P.O. Box 50031
Bachbrecht
Windhoek
Namibia

Dear Ms. Thomas

Re: Comparing the risk of Tuberculosis(TB) Infection in the Households with and without TB patients in Tsumukwe constituency, Otjozondjupa region.

1. Reference is made to your application to conduct the above-mentioned study.

2. The proposal has been evaluated and found to have merit.

3. **Kindly be informed that permission to conduct the study has been granted under the following conditions:**

3.1 The data to be collected must only be used for academic purpose;

3.2 No other data should be collected other than the data stated in the proposal;

3.3 Stipulated ethical considerations in the protocol related to the protection of Human Subjects should be observed and adhered to, any violation thereof will lead to termination of the study at any stage;

3.4 A quarterly report to be submitted to the Ministry's Research Unit;

3.5 Preliminary findings to be submitted upon completion of the study;

3.6 Final report to be submitted upon completion of the study;

3.7 Separate permission should be sought from the Ministry for the publication of the findings.

Yours sincerely,

PERMANENT SECRETARY
2015-08-28
REPUBLIC OF NAMIBIA
MINISTRY OF HEALTH AND SOCIAL SERVICES

Andrew Ndishishi (Mr)
Permanent Secretary